6-Baseband Description and Troubleshooting

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Baseband Top-Level Description

Product RH-4 is a hand portable EGSM900, GSM1800, GSM-1900 DCT-4 generation phone for the smart classic segment.

The RH-4 Baseband consists of the DCT4 common Baseband chipset having some product specific blocks of its own, such as pop-port system connector (also unofficially known as "Tomahawk"), IHF, IrDA and a color display.

The Baseband engine consists basically of two major ASIC's.

- The UEM is the Universal Energy Management IC. It includes the analog audio circuits, the charge control and voltage regulators.
- The UPP is the Universal Phone Processor and contains DSP, MCU and some internal memory.

Baseband Block Diagram

The below system block shows the main BB function blocks.

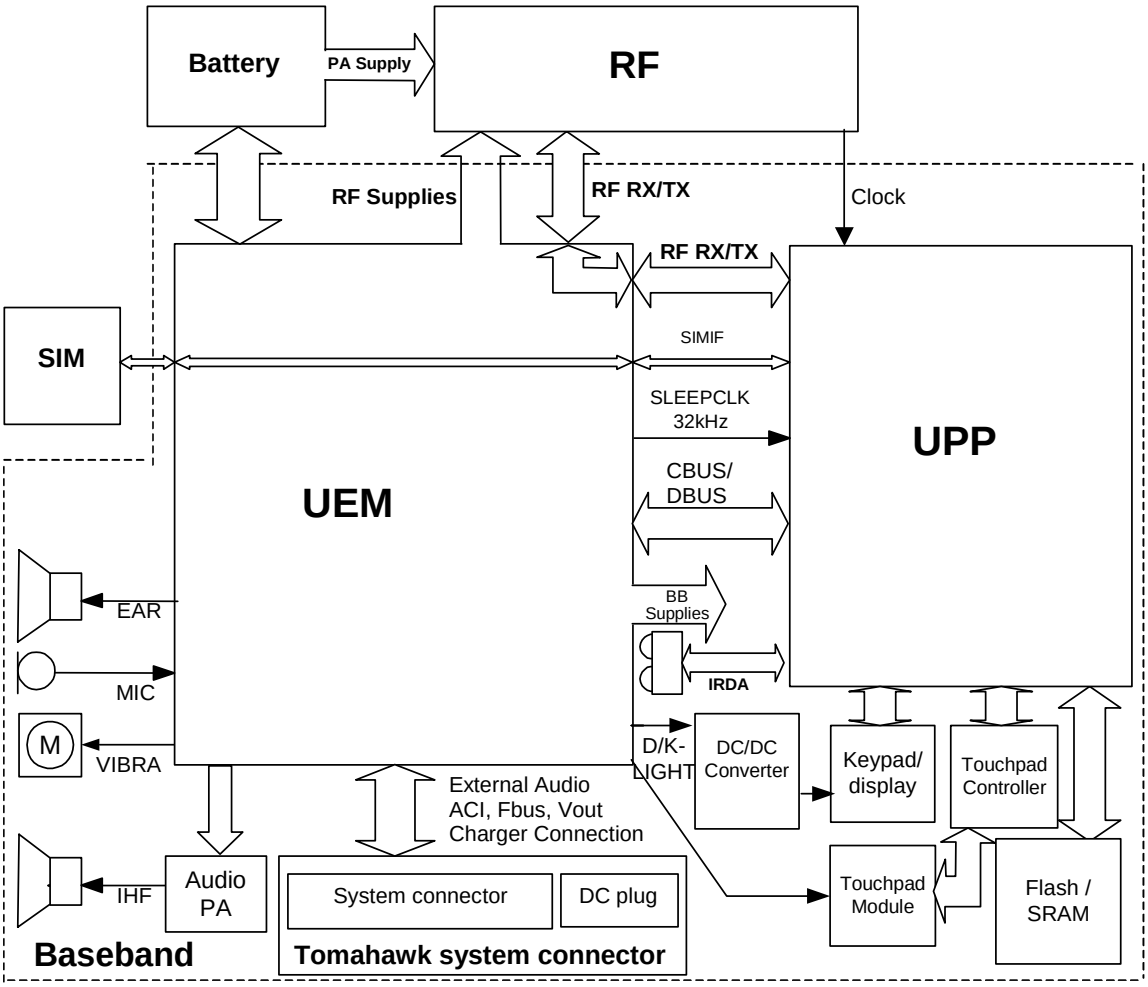

Figure 1: Baseband Block Diagram

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RH-4 Baseband Feature List

Hardware characteristics:

- Single PWB design
- Universal Phone Processor UPP8Mv2.x with 8Mbit internal SRAM
- Additional external 8Mbit SRAM and 128MBit FLASH memory in one single package.
- Universal Energy Management ASIC "UEM K"
- GSM triple band (900/1800/1900 MHz)
- BL-5C battery
- Internal antenna assembled on IHF container
- Small SIM, supporting 1.8 & 3.0V
- Integrated infrared module (IrDA)
- Internal vibra motor

UI features:

- 130x130 pixel color display, 4096 colors
- Standard keypad with 4-way navigation key, two soft keys and two side keys
- Illumination concept is based on a DC-DC converter
- Display: two white LED's
- Function keys: 2 LED's
- Number keys: 4 LED's
- Touchpad: EL
- Polyphonic ringing tones (MIDI)
- Internal hands-free

Environmental Specifications

Normal and Extreme Voltages

Following voltages are assumed as normal and extreme voltages for used battery:

- Nominal voltage: 3.6 V
- Lower extreme voltage: 3.1 V
- Higher extreme voltage (fast charging): 4.4 V

Temperature Conditions

Operational temperature range (all specifications met within this range)

-10°C..+55°C

Functional temperature range (Reduced performance) -30°C..+70°C

Storage temperature range: -30°C..+85°C

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Humidity

Relative humidity range is 5...95%.

The BB module is not protected against water. Condensed or splashed water may cause interim or permanent phone malfunction.

Any submerge of the phone most likely causes permanent damage.

Frequencies in Baseband

There are several clock frequencies at the baseband part. Below table lists all available frequencies. The asynchronous and diagnostic busses are not included.

Table 1: Frequency list

Frequency	Context	UPP	UEM	Flash	SIM	Comment
54 MHz	Memory clock	X		X		
26 MHz	RF clock	X				
13 MHz	DBUS, RFBusClk	X	X			
3.25 MHz	SIM		X		X	
Up to 1 MHz	RFConvClk	X	X			Estimation
1 MHz	CBUS	X	X			
32 kHz	Sleep clock		X			
1.2 kHz	ACI	X	X			
6.5 Mhz max	Display IF	X				Frequency depends on SW
400 Hz	EL Driver					Application
500 Hz	TP Controller	X				

Printed Wire Board (PWB)

Characteristics of the PWB

- Single PWB
- 1.2 mm, 8 layer board
- Double sided assembled
- Through holes, vias and buried vias are possible

The PWB is prepared for I-Line Underfilling of UEM, UPP, touchpad controller and Combo memory (128+8 Mbit SRAM/Flash).

Infrared Interface (IrDA)

RH-4 supports data connectivity via an Infrared link. An IR module is integrated into the phone, connected to the IR interface of the UPP ASIC. RH-4 uses the Rohm RPM960 (4860121).

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Baseband Architecture

Baseband Core

Universal Phone Processor (UPP)

Main characteristics of the used UPP are:

- DSP by Texas Instruments, LEAD3 PH2+ Megacell 16 bit DSP core, 32 bit I/F - max. speed 200 MHz.
- MCU based on ARM/Thumb 16/32 bit RISC MCU core - max. speed 50 MHz
- Internal 8 Mbit SRAM (PDRAM)
- General purpose USARTs
- SIM card interface
- Accessory interface (ACI)
- Interface control for: keypad, LCD, audio and UEM control
- IrDA interface
- Handling of RF-BB interface

The UPP is housed in a 144-pin uBGA package (12x12mm, 0.8mm pitch).

In RH-4 the UPP is clocked by a 26MHz frequency from the RF-chip "Mjölner"

This 26MHz-clock frequency is internally sliced down by UPP to 13MHz. This frequency is then inside UPP multiplied to different frequencies, e.g. 145MHz for the DSP core.

UPP can operate on 4 different voltages; 1.05,1.3,1.5 and 1.8V. The voltage can be programmed "on the fly" by the SW. For example in standby-mode, 1.3V is used for power saving, but in active-mode (i.e. call) the voltages is increased to 1.8V to get maximum performance.

Universal Energy Management (UEM)

RH-4 uses the UEM version so called "UEM K". UEM K is a die shrinked version of standard UEM's, but with the same functionality.

Main characteristics of UEM's are:

- ACI support
- Audio codec
- 11 Channel A/D converter
- Auxiliary A/D converter
- Real time logic
- 32 kHz crystal oscillator
- SIM interface and drivers
- Security logic
- Storage of IMEI code

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- Buzzer and vibra motor drivers
- 2 LED drivers
- IR Interface
- Voltage references needed for analogue blocks
- Charging function
- Baseband regulators
- RF regulators
- RF interface converters

The UEM is housed in a 168-pin uBGA package (12x12mm, 0.8mm pitch).

External Flash and External SRAM

The Combo-Memory is a multi chip package memory which combines 64Mbit (4Mx16) muxed burst multi bank Flash and 4Mbit muxed CMOS SRAM. These two dies are stacked on each other in one package. The functionality of the Flash memory is the same, as it is known from generic BB4.0 products.

The combo is supplied by single 1.8V for read, write and erase operation.

This Combo memory is housed in a 48-ball TBGA type with a 0.5mm ball pitch. The outer dimensions are 10x8mm and the thickness is 1.1 mm.

Energy Management

The energy management of RH-4 is based on BB 4.0 architecture. A so called semi fixed battery (BL-5C) supplies power primarily to UEM ASIC and the RF PA. UEM includes several regulators to supply RF and baseband. It provides the energy management including power up/down procedure.

If the main battery is not present, a capacitor maintains backup power supply for the Real Time Clock (RTC) part of UEM.

Power Supply Modes

The functional behavior of the UEM can be divided into 7 different states. Since the UEM controls the regulated power distribution of the phone, each of these states affects the general functionality of the phone:

- No supply
- Backup
- Power off
- Reset
- Power on
- Sleep
- Protection

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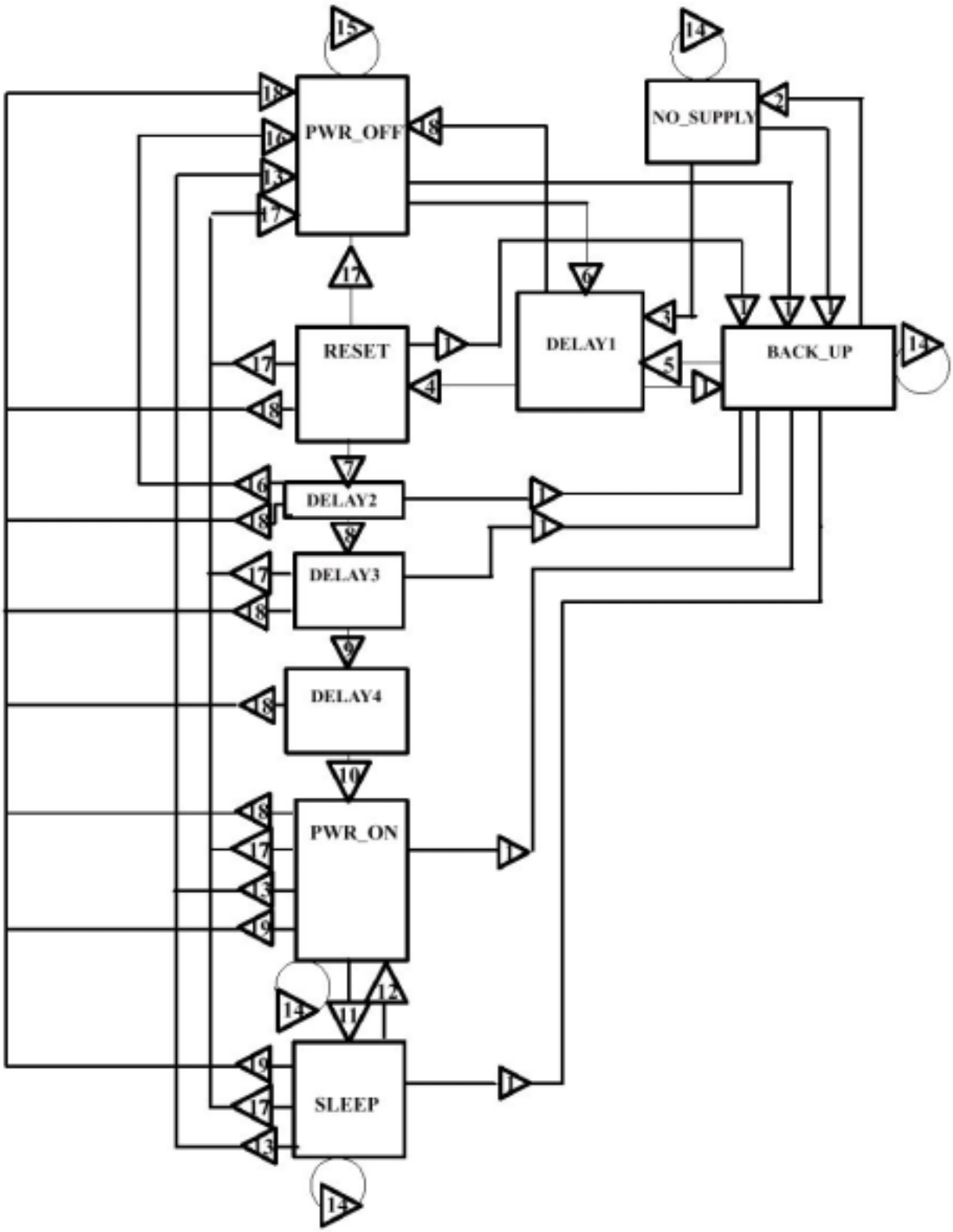

Figure 2 UEM state diagram

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The text below explains the state diagram. The symbol '↗' means that the voltage rises and '↘' that the voltage drops. '→' Means the result of the conditions set on the left most side.

VBAT < V_{MSTR}	and VBACK > V_BU_{COFF}	→ BACK_UP
VBAT < V_{MSTR}	and VBACK < V_BU_{COFF}	→ NO_SUPPLY
VBAT ↗ V_{MSTR+}	and VBACK < V_BU_{COFF}	→ DELAY1
VBAT > V_{MSTR}	and DELAY1 elapses	→ RESET
VBAT ↗ V_{MSTR+}	and VBACK > V_BU_{COFF}	→ DELAY1
PWRONX = '0'	or VCHAR ↗ $VCHAR_{DET+}$ or ALARM = '1'	→ DELAY1
VBAT > V_{COFF+}		→ DELAY2
DELAY2 elapses		→ DELAY3
VBAT > C_{OFF+}.	and DELAY3 elapses	→ DELAY4
DELAY4 elapses		→ PWR_ON
SLEEPX = '0'		→ SLEEP
SLEEPX = '1'		→ PWR_ON
VBAT ↘ V_{COFF}	and VBAT > V_{MSTR-}	→ PWR_OFF
No change		
VBAT > V_{MSTR}		→ Stay in PWR_OFF
PWRONX ↗ detection during DELAY2		→ PWR_OFF
Watchdog elapses (approx. 100 (s)		→ PWR_OFF
Thermal shutdown		→ PWR_OFF
PwrKeyWatchdog (4 sec.) elapses		→ PWR_OFF

The different states of the UEM are detailed in the sections below.

No Supply

In the NO_SUPPLY mode the UEM has no supply voltage (VBAT < V_{MSTR} and VBACK < V_BU_{COFF-}). This mode is due to the fact that both the main battery and the backup battery are either disconnected or both discharged to a low voltage level.

The UEM will recover from NO_SUPPLY into RESET mode if the VBAT voltage level rises above the V_{MSTR+} level by either reconnecting the main battery or charge it to such level.

Backup

In BACK_UP mode the main battery is either disconnected or has a low voltage level (VBAT < V_{MSTR-} and VBACK > V_BU_{COFF+}).

The regulator VRTC that supplies the real time clock is disabled in BACK_UP mode. Instead the unregulated backup battery voltage VBACK supplies the output of the VRTC. All other regulators are disabled and the phone has no functionality.

The UEM will recover from BACK_UP mode into RESET mode if VBAT rises above V_{MSTR+}.

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Power Off

In order for the UEM to be in PWR_OFF mode, it must have supply voltage (VBAT > V_{MSTR+}).

The regulator VRTC regulator is enabled and supplying the RTC within the UEM. The UEM will enter RESET mode after a 20 ms delay whenever one of the below listed conditions is logically true:

- The power button is activated
- Charger connection is detected
- RTC alarm is detected

The UEM will enter PWR_OFF from all other modes except NO_SUPPLY and BACK_UP if the internal watchdog elapses.

Reset

When the UEM enters RESET mode from PWR_OFF mode the watchdog is enabled. If the VBAT fails to rise above the power-up voltage level V_{COFF+} (3.1 V) before the watchdog elapses, the UEM will enter PWR_OFF mode. Otherwise after a 200 ms delay the regulator VFLASH1 will be enabled and after an additional delay of 500 µs the regulators VANA, VIO, VCORE and VR3 will be enabled. All other regulators i.e. VFLASH2, VSIM, VR1, VR2 and VR4 - VR7 are software controlled and disabled by default. After an additional delay of 20 ms the UEM enters PWR_ON mode.

Power On

In PWR_ON the UEM is fully functional in the sense that all internal circuits is powered up or can be by means of software. The UEM will enter PWR_OFF mode if VBAT drops below V_{COOF-} for a period of time longer than 5 µs. The UEM will furthermore enter PWR_OFF mode if either of the watchdogs Operational State Machine (approx. 100 µs), Security (32 sec.) or Power Key (4 sec.) elapses or if any of the regulators triggers the thermal protection circuitry

Sleep

The UEM can be forced into SLEEP mode by the UPP by setting the input SLEEPX low for more than 60 µs. This state is entered when the external UPP activity is low (phone in sleep) and thereby lowering the internal current consumption of the UEM. The regulator VANA is disabled and VR1 - VR7 are either disabled or in low quiescent mode.

From SLEEP the UEM enters PWR_ON if SLEEPX goes high, PWR_OFF mode if watchdog elapses or BACK_UP mode if VBAT drops below V_{MSTR-}.

Protection Mode

The UEM has two separate protection limits for over temperature conditions, one for the charging switch and one for the regulators. The temperature circuitry measures the on-chip temperature. In case of charging over temperature, the circuit turns the charging switch off. In case of over temperature in any of the regulators, the UEM powers off.

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Battery BL-5C

Product RH-4 uses the so called "case-less" Li Ion battery BL-5C.

BL-5C battery capacity is 850mAh.

Main advantage of case-less battery types is the overall size, particular the thickness and the number of contact terminals.

This battery has a three-pin connector (BTEMP is not used). The battery does not support temperature measurement inside battery pack. In order to get temperature information of the battery, a NTC is mounted on the PWB within the BB area.

Ni based batteries are not supported by RH-4.

The resistor value for battery size indication (BSI) is 75 kohm.

RTC Capacitor

To sustain the RTC when BL-4C is removed from the phone, a backup capacitor is used in RH-4. This capacitor is soldered directly to the PWB. Its capacity is 0.01 mAh. This provides approx. 7 hours of back up time.

Power Distribution

Under normal conditions, the battery powers the baseband module. Individual regulators located within the UEM regulate the battery voltage **VBAT**. These regulators supply the different parts of the phone. 8 regulators are dedicated to the RF module of the phone, and 6 to the baseband module.

The **VSIM** regulator is able to deliver both 1.8V and 3.0V DC and thus supporting two different SIM technologies. A register internally in the UEM controls the output of VSIM and can be written to by the MCU via the CBUS.

The regulator **VCORE** is likewise adjustable and controlled by registers written by the MCU. VCORE supplies the core of the UPP and can be adjusted on the fly by the MCU if DSP capacity is inadequate. Higher VCORE supply (1.8 V) results in faster core operations in the UPP.

The regulator **VFLASH2** supplies the EL circuitry and EL sheet in touchpad module. The regulator is controlled by the MCU

Regulators **VANA, VFLASH1** and **VIO** are solely controlled by the UEM and cannot be enabled or disabled by the MCU. Furthermore, VFLASH1 and VIO are both ON, though in low quiescent mode when phone is in sleep mode. An output current of 500 µA can be drawn from the regulators. VIO supplies the UPP, FLASH and LCD, VFLASH1 supplies LCD and the IrDA module. VANA is supplying analogue parts internally in the UEM as well as the baseband audio circuitry and pull-up resistors on the input of the UEM slow AD converters.

System connector provides a voltage to supply accessories. The white LED's need a higher

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voltage supply as the battery can provide in bad condition. Separate external regulators supply both consumers.

The regulators **VR1A, VR1B, VR2 – VR7** and **IPA1 – IPA4** are controlled by the DSP via the DBus. VR4 - VR7 are controlled by the UEM as well and are disabled in sleep regardless of DSP writings.

VBAT is furthermore distributed, unregulated, to the RF power amplifier, audio power amplifier and external baseband regulators.

The CHACON module in the UEM controls the charging of the main battery. Furthermore it contains a 3.2 Vdc regulator for charging of the backup battery and a 1.8 Vdc regulator supplying the internal real time clock.

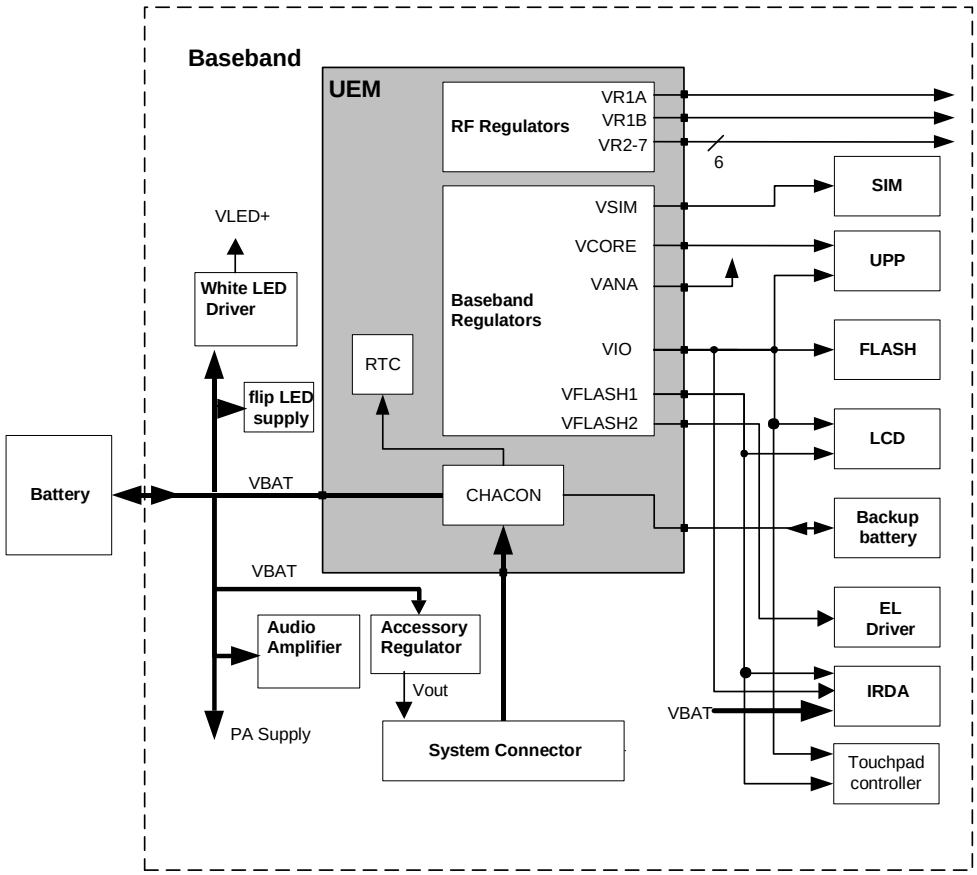

Figure 3: Baseband power distribution

DC Characteristics

The following table reflects the specifications of voltage and current regulators within the UEM:

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Table 2: UEM regulator outputs

Regulator	Target	Output Voltage (V)			Output Current (mA)	
		Min	Typ	Max	Min	Max
VR1A	RF	4.6	4.75	4.9	0	10
VR2[4]	RF	2.70	2.78	2.86	0.1	100
VR3	RF	2.70	2.78	2.86	0.1	20
VR4	RF	2.70	2.78	2.86	0.1	50 0.1
VR5, VR6[1]	RF	2.70	2.78	2.86	0.1	50 0.1
VR7	RF	2.70	2.78	2.86	0.1	45
VrefRF01	RF	1.334	1.35	1.366	-	0.1
VIO[1]	BB	1.72	1.8	1.88	0.005 0.005	150 0.500
VSIM[2]	BB	1.745 2.91	1.8 3.0	1.855 3.09	0.005 0.005	25 0.500
VANA	BB	2.70	2.78	2.86	0.005	80
VCORE[2]	BB	1.000 1.235 1.425 1.710	1.053 1.3 1.5 1.8	1.106 1.365 1.575 1.890	0.005 0.005 0.005 0.005	70 85 100 120
		0.974 1.215 1.410 1.692	1.053 1.3 1.5 1.8	1.132 1.365 1.575 1.890	70 85 100 120	200 200 200 200
VFLASH1	BB	2.70	2.78	2.86	0.005 0.005	70 1.5
VFLASH2[3]	BB	2.70	2.78	2.86	0.005	40

1 The second current value indicates the maximum possible output current of the regulator when in low quiescent mode.

2 The output voltages are split into two different current categories. The upper part is the lower range of output current, and the lower part is the higher range of output current.

3 Condition in sleep-mode depends on MCU writings to UEM regulator register solely.

4 Condition in sleep-mode depends on DSP writings to UEM register.

Charging

The charging of the main battery is controlled by the UEM. External components are needed in order to sense charging current and voltage that are needed by the Energy Management (EM) software and to protect against EMC into the baseband area. The charger is connected to the phone via the DCT3 bottom connector or the charger pads of the Pop-port system connector.

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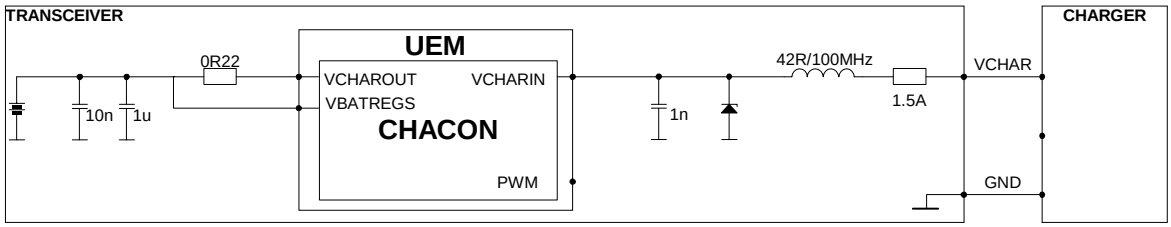

Figure 4: Charging configuration

Connecting a charger to the telephone creates a voltage, VCH, on the UEM VCHAR input. When the VCH level is detected to rise above the VCH_{DET} threshold (2.0 Vdc) by CHACON, charging starts.

3-wire chargers can be connected, but the PWM is not supported.

In order to protect the phone from damage due to over voltage caused by a sudden battery removal while charging proceeds, the charger switch is closed immediately.

Audio Circuitry

This section describes the audio-HW inside the BB. Thus e.g. external audio components and acoustics are not considered with the details in this section.

The main topology comes from other phones using BB4.0 engine, where the audio-HW is mostly integrated into the UEM-ASIC. The biggest difference is that Maxwell has also integrated hands-free (IHF).

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Audio Block Diagram

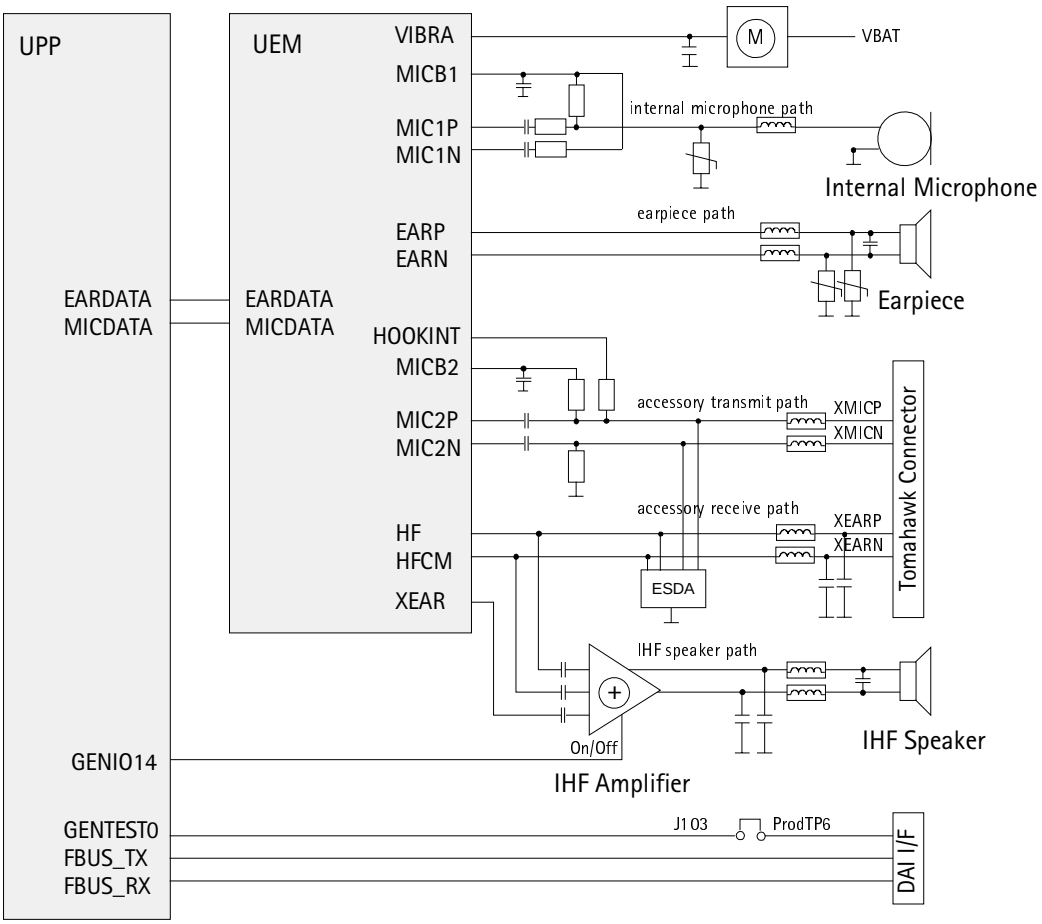

Figure 5: Audio Block Diagram

Earpiece

RH-4 uses an earpiece which is also referred to as "PICO speaker". This is a 32 ohm speaker with the diameter of 8 mm.

Earpiece is fed by the differential signals "EARP" & "EARN" from UEM. The signals run quite directly from UEM to the earpiece, only some passive ands EMC protection components are needed.

The external earpiece signals is fed by the "HF" & "HFCM" pins.

The level (swing) of earpiece-signals can be adjusted by register values inside UEM. These signals have common voltage level of 1.35 V (0.8 V for HF) at UEM pins.

Microphones

An EMC-improved type of microphone is used as internal microphone in RH-4, diameter of which is 2.2mm.

Internal Microphone circuitry is driven single ended. Microphone needs bias voltage, which is provided by UEM and is fed through a resistor to the microphone. A resistor is

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also needed to other side of the microphone, i.e. between microphone and GND, in order to provide the differential signals to UEM. Audio signals are AC-coupled from the microphone.

For the external microphone a differential input is used.

MIC1N & MIC1P (audio signals) and MICB1 (bias voltage) are used for the internal microphone. MIC2N & MIC2P and MICB2 are used for external microphone.

Integrated Hands-free (IHF)

The speaker used for IHF is a 16 mm diameter speaker with 8 Ohm impedance, and is also known as "MALT" speaker.

IHF circuitry uses differential outputs from UEM.

Depending on the audio mode the IHF amplifier is driven either from UEM HF / HFCM or XEAR audio outputs. The IHF audio power amplifier (APA) LM4890 has a bridge-tied-load (BTL) output in order to get the maximum use of supply voltage. The supply voltage for driving circuitry of speaker is VBAT, thus the swing across the speaker is (VBAT.

The shutdown of the IHF PA is controlled by UPP using GENIO14.

Audio Accessory Receive Path

In RH-4 the accessory receive path is directly driven from UEM HF / HFCM differential audio outputs, the output signal complies with the Pop-port accessory interface.

For EMC protection ferrites are connected in series to the earpiece, for ESD protection varistors are used.

Audio Control Signals

Furthermore, a couple of signals are needed to control the external audio device.

The HEADINT signal is needed for recognizing the external device (e.g. headset) connected to the system. The recognition is based on the ACI-pin on the system connector, which is shorted to ground inside the external device.

The button of the external device generates HOOKINT. This is used e.g. to answer or to end a phone call.

Acoustics

Earpiece Acoustic

RH-4 uses the so called "PICO" earpiece.

This earpiece is mounted into the UI-shield assembly, the sealing of the back and front volume are implemented in the UI-shield by die casting. This sealing part also provides the sealing against the A-cover.

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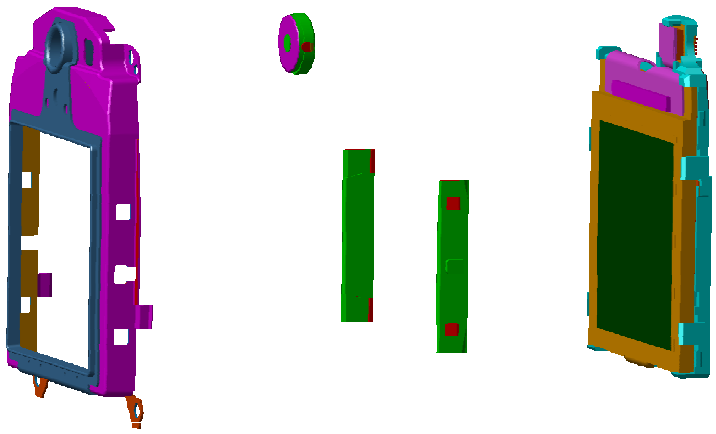

Figure 6: Earpiece implementation

IHF Speaker Acoustics

As mentioned, the so called "MALT" speaker is used in RH-4 for integrated hands-free and ringing tone applications.

The IHF speaker is mounted to the IHF enclosure by means of the speaker adhesive. The IHF enclosure provides the needed back volume for the speaker. The IHF enclosure is closed with the IHF lid, which is carrying the IHF pins to contact the IHF speaker.

The sealing of the effective acoustic volumes is achieved with the enclosure adhesive, which glues the IHF lid to the IHF enclosure.

To provide a long-term reliability additionally the IHF lid is heat stacked to the IHF enclosure.

The B-cover gasket provides a fitting between the B-cover and the IHF enclosure. This fitting is attached with an adhesive to the IHF enclosure and also includes a dust and water shield to protect the speaker inside from dust and swarf.

Due to the fact that the IHF enclosure is also carrying the antenna radiator, the whole assembly is named antenna assembly.

Due to heat stacking of the antenna assembly, it cannot be disassembled and in case of failure only be exchanged as one complete assembly.

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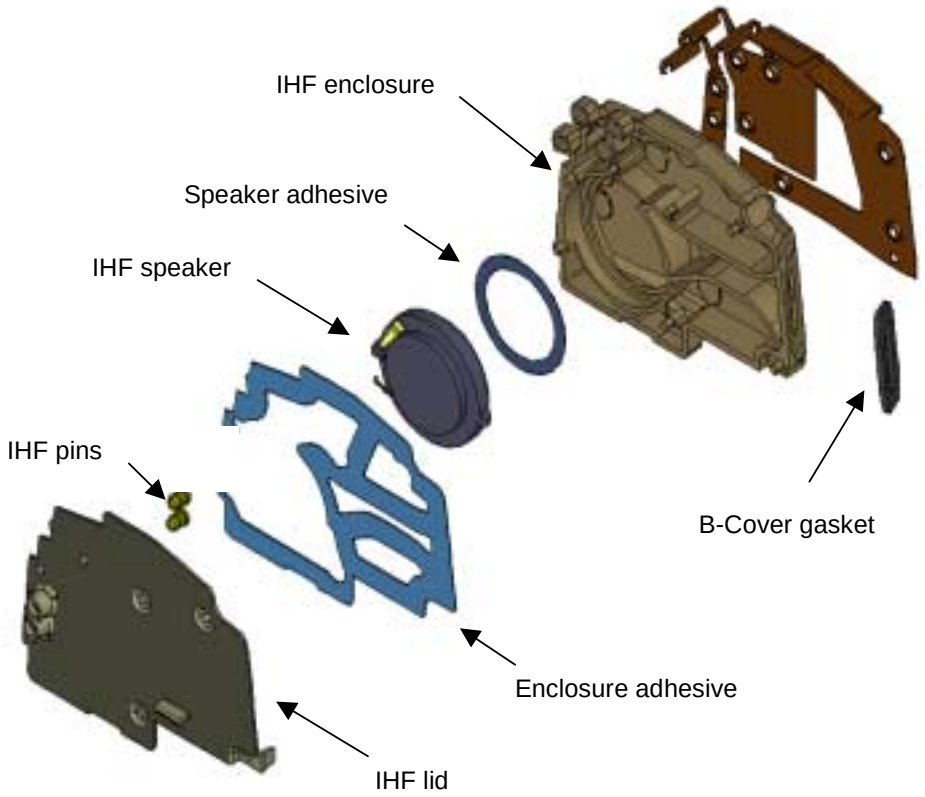

Figure 7: Exploded View of Antenna Assembly

Microphone Acoustics

A standard microphone module is used. This module is embedded into a so called "rubber boot" and connected to RH-4 system module by spring contacts.

The microphone is placed close to the system connector. Tthe sound port of the microphone is located towards the bottom of the phone

Vibra Motor

A vibrating alerting device is used to generate a vibration signal for an incoming call.

This vibra is located in the bottom section of the phone.

The vibrator is driven by the UEM output VIBRA, and controlled with a PWM signal. The supply of the vibra is taken from the battery voltage of the phone.

Audio Modes

There are six different audio configurations. These can create following audio modes:

- Hand portable
- Integrated hands-free
- Headset
- Loop set
- External hands-free

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The following audio sources have to be routed according to the active audio mode:

- Speech
- Ringing tones / SMS tones
- Keypad tones
- Error tones / Warning tones
- Game tones

Hand Portable Mode

In hand portable mode earpiece path and internal microphone path are in use. The audio sources are routed according to the following table:

Table 3: Handportable mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Speech	X	X			
Ringing tones, SMS tones			X		
Keypad tones	X				
Warning / Error tones			X		
Game tones			X		

Integrated Hands-free Audio Mode

In integrated hands-free mode IHF path and internal microphone path are used. The audio sources are routed according to the following table:

Table 4: IHF mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Speech		X	X		
Ringing tones, SMS tones			X		
Keypad tones			X		
Warning / Error tones			X		
Game tones			X		

Headset Audio Mode

In headset mode accessory receive path and accessory transmit path are used. RH-4 supports the following headsets:

HDB-4:Mono Headset, boom design HDC-xxx:Mono Headset, traditional design

The audio sources are routed according to the following table::

Table 5: Headset mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Speech				X	X

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Table 5: Headset mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Ringing tones, SMS tones			X	X	
Keypad tones				X	
Warning / Error tones				X	
Game tones				X	

Loop set Audio Mode

In loop set mode accessory receive path and accessory transmit path are used. RH-4 supports the loop set LPS4.:

Table 6: Loop set mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Speech				X	X
Ringing tones, SMS tones			X	X	
Keypad tones				X	
Warning / Error tones				X	
Game tones				X	

External Hands-free Audio Mode

In external hands-free mode accessory receive path and accessory transmit path are used. RH-4 supports external hands-free accessories:

BHF-1: basic car hands-free kit

HFU-4: advanced car hands-free kit

Table 7: External hands-free mode audio routing

Audio Source	Earpiece	Internal Microphone	IHF speaker	Accessory receive path	Accessory transmit path
Speech				X	X
Ringing tones, SMS tones				X	
Keypad tones				X	
Warning / Error tones				X	
Game tones				X	

User Interface

LCD module

Maxwell is using a 130 * 130 dot LCD display with 4096 colors. The illumination is integrated into the LCD module.

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Baseband-LCD interface

The LCD display is connected to the transceiver PWB by 10-pin board-to-board connector.

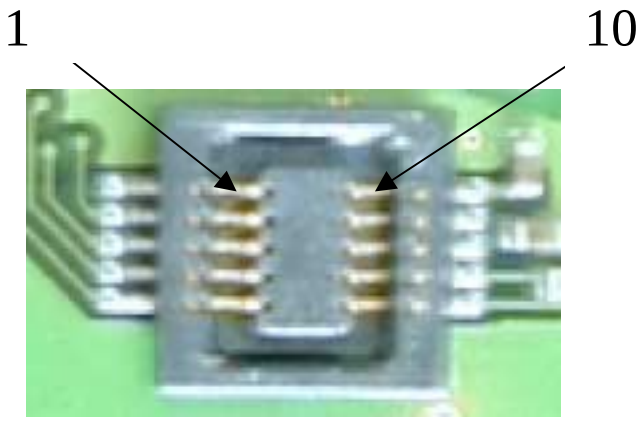

Figure 8: LCD connector

DC Characteristics

Display is using 3-wire serial interface. Signals for LCD panel are shown in table below.

The chip-select **XCS** (active low) enables and disables the serial interface. **RESX** (active low) is external reset signal. The **SCL** is serial data clock. **SI** data-length is 8 bits + **D/C**-bit. First bit is **D/C**-bit which indicates the status of following 8 bit data. In case of command data **D/C**-bit is low ('0'). **VDDI** is logic voltage supply for the display. **VDD** is supply voltage for high voltage generation. **GND** is system ground for display.

Table 8: LCD Interface DC Characteristics

Pin No	Signal name	Interface	Min	Typical	Max	Unit	Description
1	VDDI	VIO	1.7	1.8	VDD	V	Logic voltage supply
			-	0.8	1.2	µA	Logical supply current in full mode
			-	0.8	1.2	µA	Logical supply current in partial mode
2	RESX	GENIO(4)	H: 0.7xVDD L: 0		H: VDDI L: 0.3xVDDI	V	Reset (active low)
3	SI	LCDUI(1)	H: 0.7xVDDI L: 0		H: VDDI L: 0.3xVDDI	V	Serial input
4	SCL	LCDUI(0)	H: 0.7xVDDI L: 0		H: VDDI L: 0.3xVDDI	V	Serial input clock
					6.5	MHz	Serial data clock speed
5	XCS	LCDUI(2)	H: 0.7XVDDI L: 0		H: VDDI L: 0.3xVDDI	V	Chip select (Active low)
6	VDD	VFLASH1	2.6	2.75	3.6	V	Voltage supply
			-	660	990	µA	Supply current in partial mode
			-	660	990	µA	Supply current in full mode
7	NC	-		-		V	Not connected
8	GND	GND	-0.3	0	+0.3	V	System ground
9	LED -	-	0.505	0.525	0.545	V	LED negative

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Table 8: LCD Interface DC Characteristics

Pin No	Signal name	Interface	Min	Typical	Max	Unit	Description
10	LED +	-		7.2	8	V	LED positive
				2.0	30	mA	LED forward current

(Note: H stands for high signal level and L for low signal level.)

Current Consumption

Table 9: LCD Interface Current Consumption

Pin No.	Signal name	Description	Min	Typical	Max	Unit	Description
6/8	VDD	Display pixels	-	0.5	1.25	mA	Full mode, 4 k colors. Maximum for chess pattern picture.
6/8	VDD	Display pixels	-	0.15	0.25	mA	Partial mode, 32 lines, 4 k colors. Maximum for chess pattern picture
9/10	LED - LED +	Display illumination	-	15	30	mA	2 white LED in series

Maximum Ratings

Table 10: LCD Interface Maximum Ratings

Item	Symbol	Rating	Unit
Power Supply voltage	V_{DD}	-0.3 to + 4.0	V
Power supply voltage (logic)	V_{DDI}	-0.3 to + 4.0	V
Signal Input voltage	V_{IN}	-0.3 to Vddi + 0.5	V
LED input current	I_{LED}	30	mA

AC Characteristics

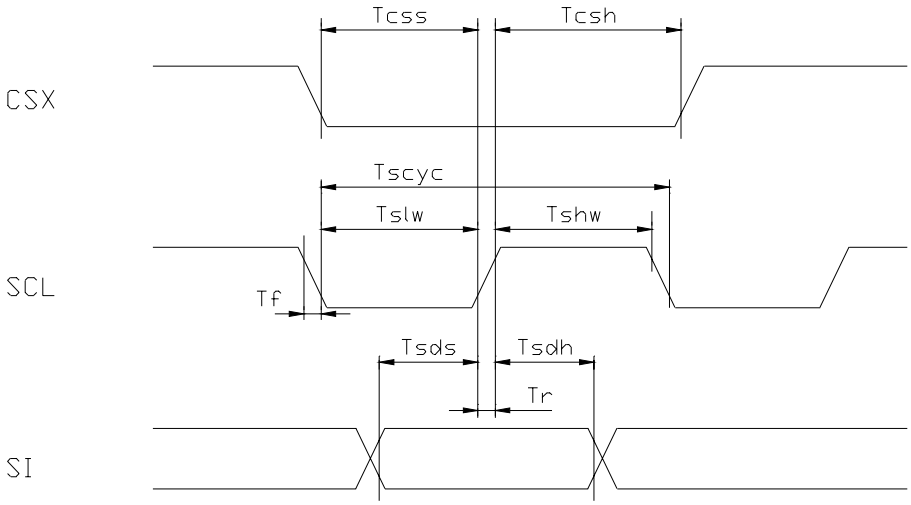

Figure 9: Write characteristics

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Table 11: AC characteristics

Signal	Symbol	Parameter	Min	Max	Unit
CSX	T_{CSS}	Chip select setup time	10	-	ns
	T_{CSH}	Chip select hold time	35	-	ns
SCL	t_{SCYC}	Clock cycle	150	-	ns
	t_{SLW}	Clock pulse "L" duration	60	-	ns
	t_{SHW}	Clock pulse "H" duration	60	-	ns
SI	T_{SDS}	Data setup time	60	-	ns
	T_{SDH}	Data hold time	60	-	ns

1. Rise tr and fall tf time must be within 15 ns maximum.

2. Timings are specified according to 30% and 70% of V_{DDI} as reference. Definitions to rise and fall times are described in the figure below.

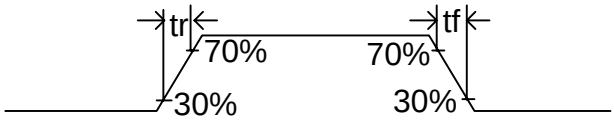

Figure 10: Rise and fall time in input and output

Table 12: Rise and fall times in input and output of display driver

Parameter	Symbol	Min	Max	Unit
Input	Tr, tf		15	ns
Output	Tr, tf		15	ns

Reset Timing

Reset timing characteristics are shown in the figure below.

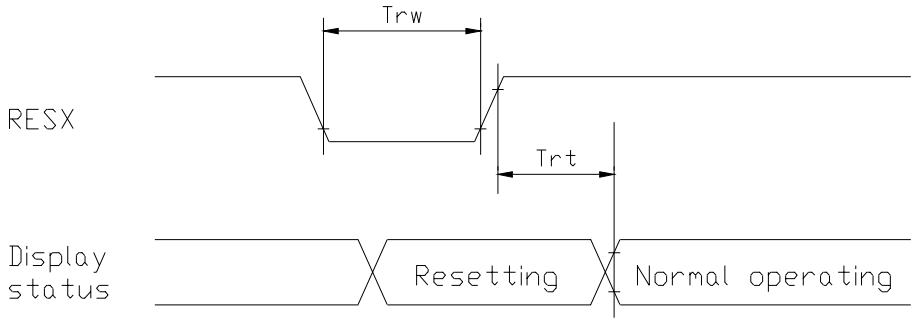

Figure 11: Reset timing

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Table 13: Reset Timing

Signal	Symbol	Parameter	Min	Max	Unit
RESX	tRW	Reset pulse duration	200		ns
	tRT	Reset cancel		1500	ns

Display Power On/Off Sequence

Power on/off sequence if described in the figure below

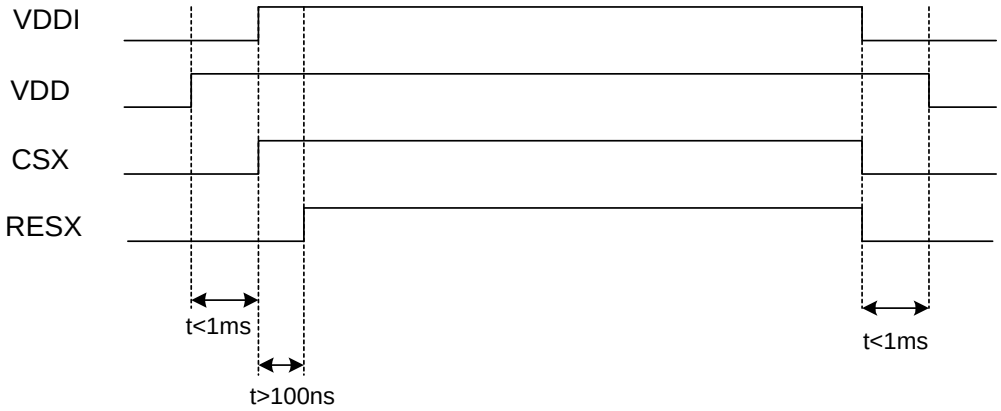

Figure 12: Power on/off Sequence

Touchpad

A 4-wire touchpad controller is the interface from UPP to the touchpad module. The main function of this device is to convert the digital format control from engine to TP controller. The control byte commands the controller to switch on/off the low on-switches in ADC input to provide power/Gnd connection to touchpad plates. Then again read the analog voltage data in AD input, convert it to digital signal and transmit to UPP in serial mode. UPP cannot inteface the controller directly with HW so the SPI^{tm} 3-wire protocol interface is made with MCU SW.

The data is read from the touchpad plates using a Texas Instruments TSC2046 controller. 4 values (x-co-ordinate, y-co-ordinate) are required for every stylus position that is measured.

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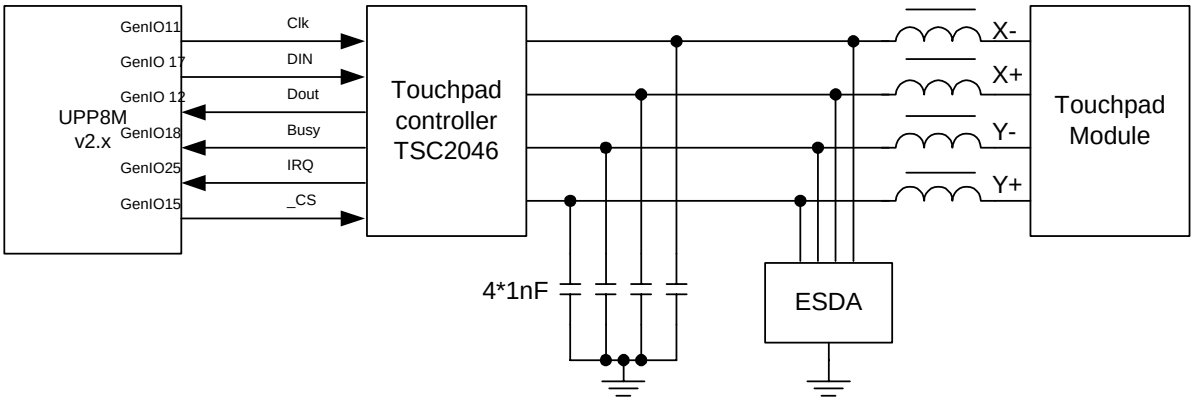
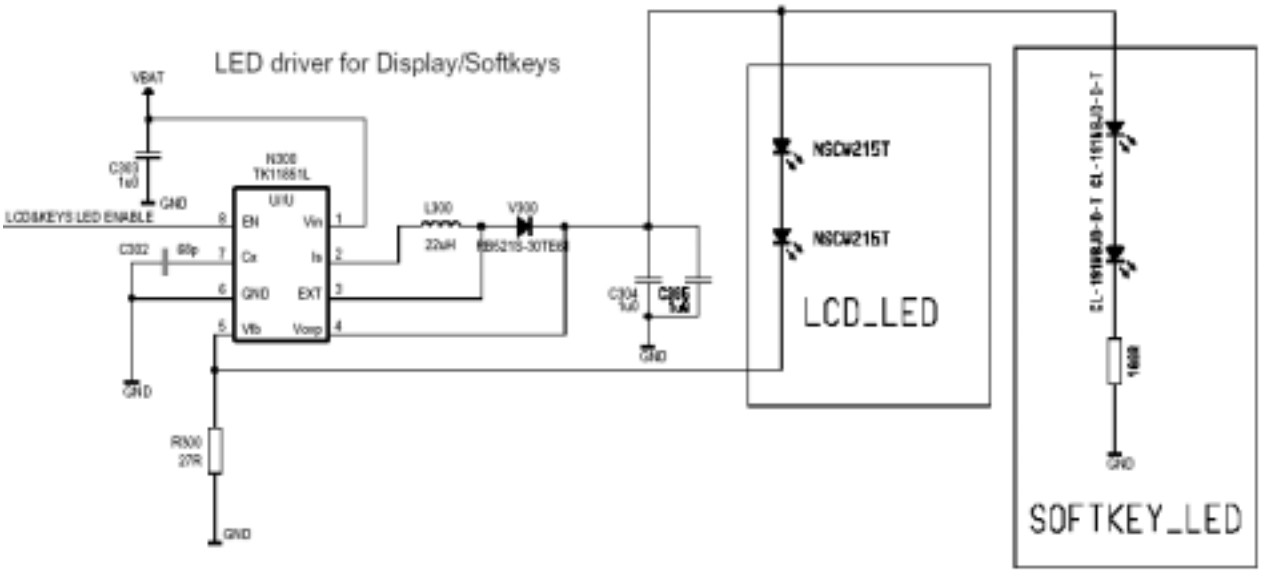


Figure 13: Touchpad module digital and analog interface connections

LED power supply for display and touchpad module

In RH-4, white LED's are used for LCD and keypad lighting. Two LED are used for LCD lighting and six LED for keyboard. A step up DC-DC converter TK11851 is used as a LED driver.



The LCD LED's are driven in serial mode to achieve stable backlight quality. This means, that constant current flow through LCD LED's. Serial resistance *Rlcd* is used to define the proper current. The feedback signal, *FB*, is used to control the current. Driver will increase or decrease the output voltage for LED's to keep the current stable.

Keyboard LED are driven in 2 serial/3 parallel modes. Serial resistance R is used to limit the current through LED's. The feedback signal, *FB*, is not used to control the current. Driver is controlled by the UEM via DLIGHT output. This signal is connected to driver EN-pin (on/off). It is possible to control the LED brightness by PWM to achieve smooth on/off operation.

RH-4 Flip backlighting is implemented with Dual transistor. Four Blue LED's (CL-191B1 are connected in parallel with shunt resistors in series. Constant current is set by external resistor (R307). The supply is VBAT.

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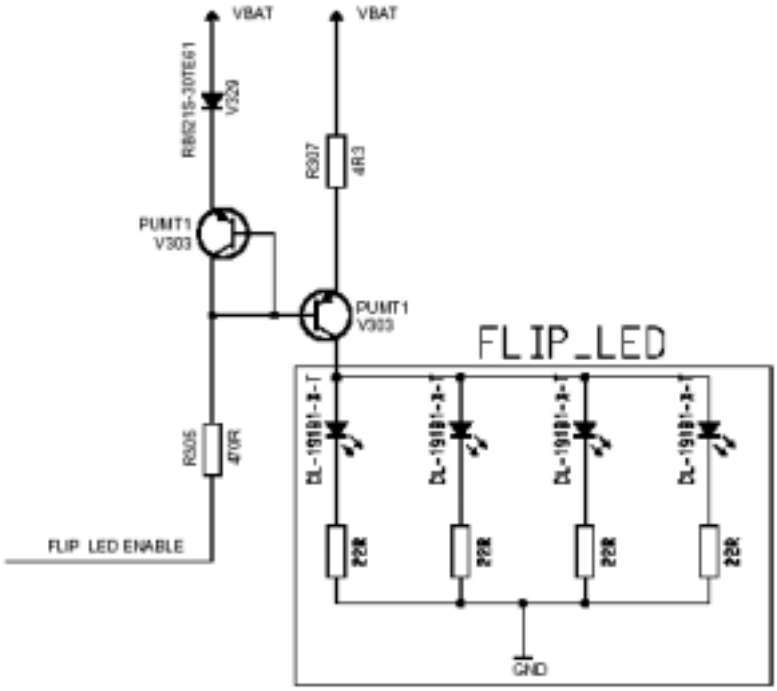
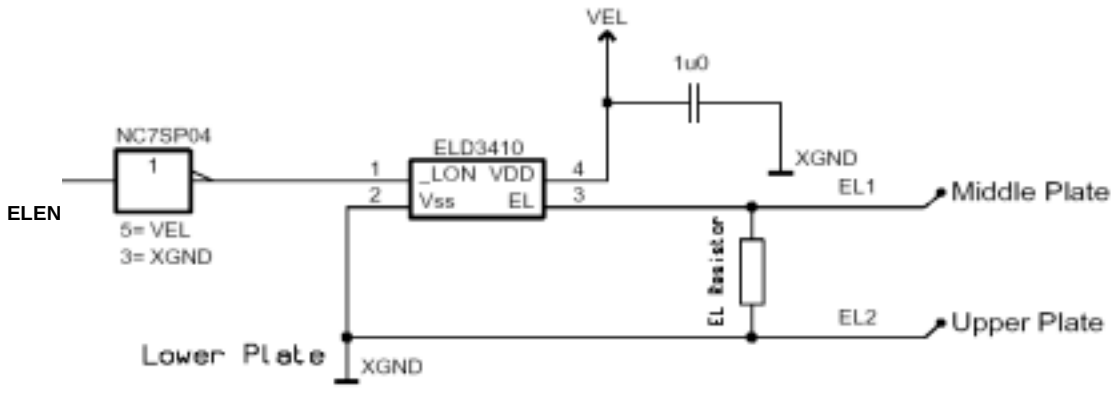


Figure 14. Flip LED driving

EL power supply for touchpad module

The EL illumination is implemented in touchpad module. The driver with surrounding components is assembled into flexi close the EL sheet to keep the audible - and electrical noise as low as possible.



Touchpad and flip module keypads

The RN-4 consists of two separate touchpad and flip modules, which include contacts for the keypad domes and LED's for keypad lighting. The touchpad module is connected to the main board with 24-pin male-female connector and the flip module uses the same 10-pin connector as the UI board.

5x4-matrix keyboard is used in RH-4. Key pressing is detected by scanning procedure. Keypad signals are connected UPP keyboard interface.

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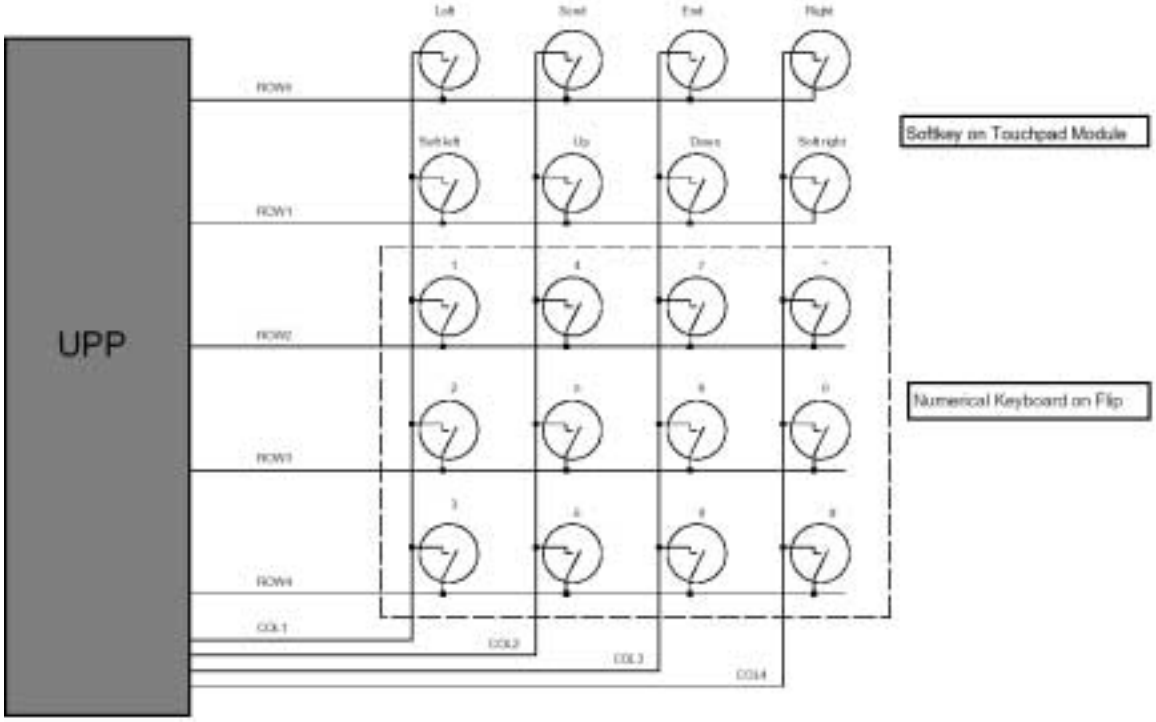

When no key is pressed, row inputs are high due to UPP internal pull-up resistors. The columns are written zero. When key is pressed one row is pulled down and an interrupt is generated to MCU. After receiving interrupt, MCU starts its scanning procedure. All columns are first written high and then one column at the time is written down. All other columns except one, which was written down, are set as inputs. Rows are read while column at the time is written down, If some row is down it indicates that key which is at the cross point of selected column and row was pressed. After detecting pressed key all register inside the UPP are reset and columns are written back to zero.

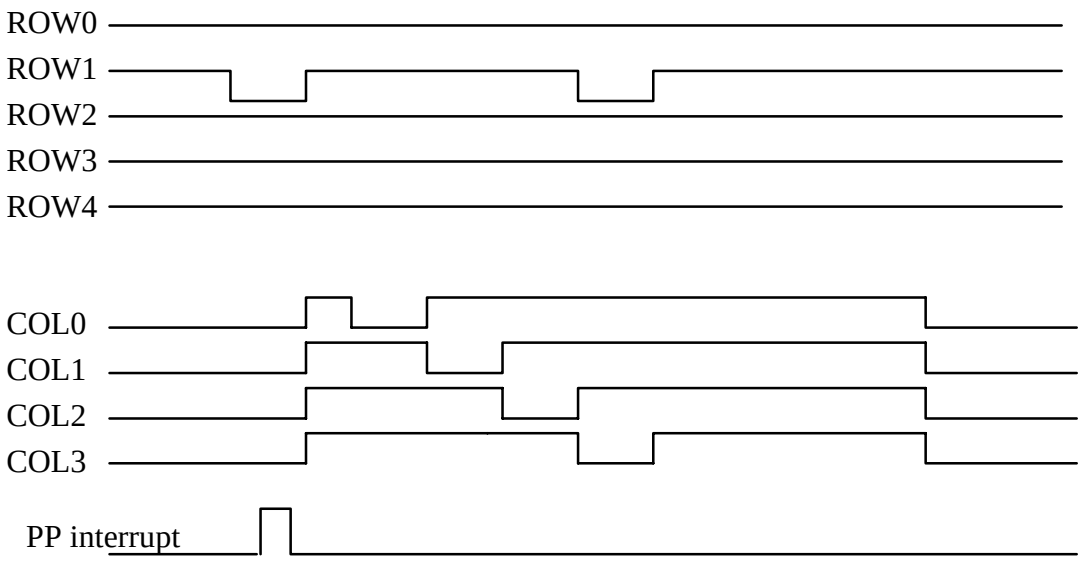

Figure 15. ROW1 and Col3 key pressed

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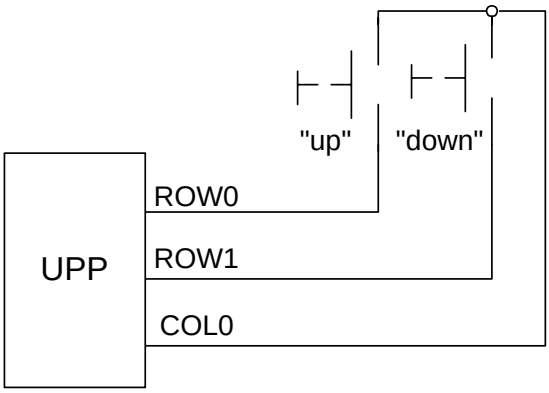

Figure 16. Side (volume) keys

SIM Interface

RH-4 uses a product specific SIM-card reader (SIM reader). Electrical connection of SIM reader is similar to other DCT4 products.

The SIM interface is split between UEM and UPP (see figure below). This has been done in order to reduce the amount of interconnections on the SIM interface between the UPP and the UEM.

The SIM interface control logic and UART is integrated into the UPP. The SIM interface start-up and power down sequence, including timing and reset generation is implemented in UEM. The SIM interface in the UPP supports the SIM speed enhancement features, which improves the data transfer rate in the SIM interface.

The UEM contains the SIM interface logic level shifting. UPP SIM interface logic levels are 1.8V. The SIM interface can be programmed to support 3V and 1.8V SIMs. A 5V SIM interface is not supported. A register in the UEM selects the SIM supply voltage. It is only allowed to change the SIM supply voltage when the SIM IF is powered down.

The SIM power up/down sequence is generated in the UEM. The Battery Type contact signal (BSI) is used to recognize if the battery suddenly is removed from the transceiver block. The SIMCardDet is not used. If the BSI goes low, the power down sequence is automatic initiated. The SIMIF will then force all the connections low, i.e. SIMRST, SIMCLK, SIMDATA and VSIM. A comparator inside the UEM does the monitoring of the BSI signal. The comparator offset is such that the comparator output does not alter state as long as the battery is connected. The BSI comparator threshold level is 2.1 V with 75 mV hysteresis.

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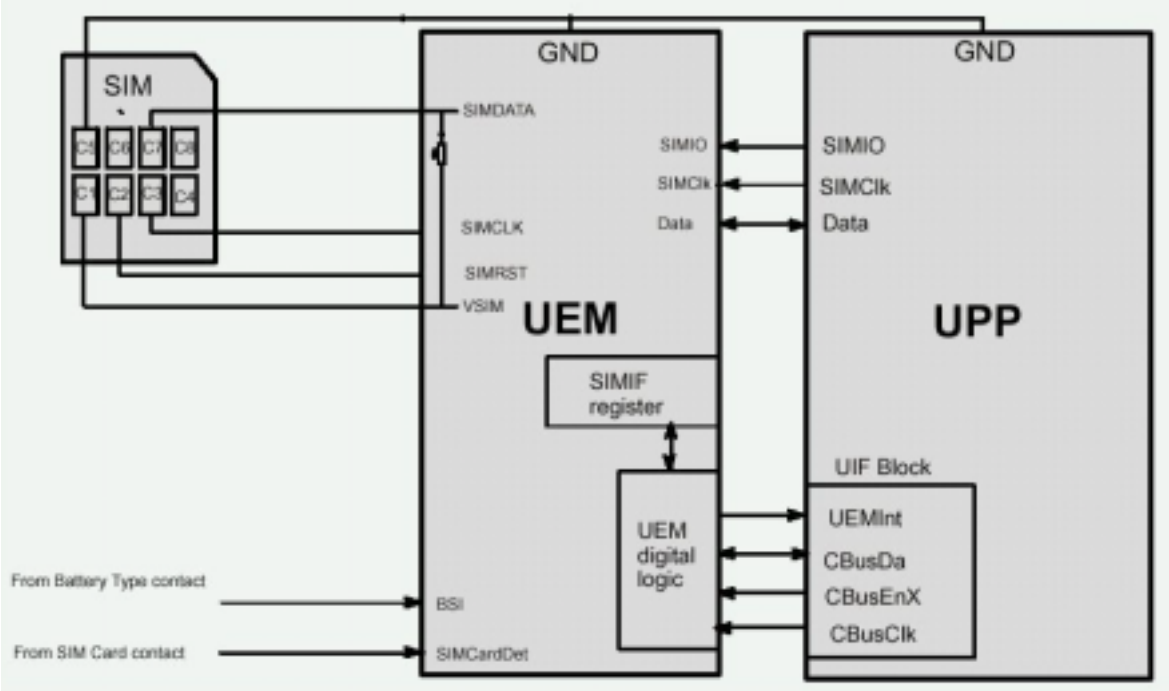

Figure 17: UPP, UEM and SIM Connections

BB-RF Interface

The below table describes all the signals from the baseband block to the RF block and back. The signal names are based on the schematics.

Digital Signals between BB and RF

For the digital interfaces UPP and Mjoelner use only level shifting IO. Level shifters of both are supplied with VIO from UEM. VIO limits are specified in chapter 0 and have been used to calculate the limits below (because VIO_{min} is 1.72V this was used for UPP V_{DDSmin} and not the limit from UPP which would have been 1.26V).

Values are refenced to GND unless otherwise specified.

Table 14: RF-BB Interface Digital Signals

Signal name	From	To	Parameter		Min	Typ	Max	Unit	Notes
RFICCNTRL (2:0)			**Mjoelner control bus**						
RFBUSEN1 RFICCNTRL(2)	**UPP** RFBUSEN1X	**Mjoelner** RFBUSENX	Logic "1"	Mjoelner input UPP output	1.22 1.37		 1.88	V V	RF Chip select. Active Low
			Logic "0"	Mjoelner input UPP output	0 0		0.4 0.40	V V	
RFBUSDA RFICCNTRL(1)	**UPP** RFBUSDA	**Mjoelner** RFBUSDA	Logic "1"	Mjoelner input UPP output Mjoelner output UPP input	1.22 1.37 1.32 1.32		 1.88 1.88	V V V V	RF serial data. (bi-directional)

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Table 14: RF-BB Interface Digital Signals

Signal name	From	To	Parameter		Min	Typ	Max	Unit	Notes
RFBUSDA RFICCNTRL(1)	**UPP** RFBUSDA	**Mjoelner** RFBUSDA	Logic "0"	Mjoelner input UPP output Mjoelner output UPP input	0 0 0 0		0.4 0.40 0.4 0.51	V V V V	RF serial data. (bi-directional)
RFBUSCLK RFICCNTRL(0)	**UPP** RFBUSCLK	**Mjoelner** RFBUSCLK	Logic "1"	Mjoelner input	1.22			V	RF bus clock.
				UPP output	1.37		1.88	V	
			Logic "0"	Mjoelner input	0		0.4	V	
				UPP output	0		0.40	V	
			Clock Speed			13		MHz	
GENIO (28:0)			**General purpose I/O**						
TXP GENIO(5)	**UPP** GENIO5	**Mjoelner** TXP	Logic "1"	Mjoelner input	1.22			V	Transmitter power control enable.
				UPP output	1.37		1.88	V	
			Logic "0"	Mjoelner input	0		0.4	V	
				UPP output	0		0.40	V	
RESET GENIO(6)	**UPP** GENIO6	**Mjoelner** RESET	Logic "1"	Mjoelner input	1.22			V	Reset to RF chip. Active low.
				UPP output	1.37		1.88	V	
			Logic "0"	Mjoelner input	0		0.4	V	
				UPP output	0		0.40	V	

Analog Signals between BB and RF

The values indicated in the table below are input requirements of the device in the "to column" when nothing else is stated. Values are refenced to GND unless other wise specified.

Table 15: RF-BB-Interface Aanlog Signals

Signal name	From	To	Parameter	Min	Typ	Max	Unit	Notes
Clock			**System clock for phone**					
RFCLK	**Mjoelner** REFOUT	**UPP** RFCLK	Frequency		26		MHz	System clock
				-20		+20	ppm	
			Duty cycle	40		60	%	
			Signal amplitude	0.3		1.32	Vpp	Upp input req.
			Setling time			5.0	ms	VR3 on to stable clock @ UPP input
RFCONV (9:0)			**RF / BB analogue signals**					
RXIINP RFCONV(0)	**Mjoelner** RXIP	**UEM** RXIINP	Max input Voltage swing	1.35	1.4	1.45	Vpp	Differential complex RX BB signal
RXIINN RFCONV(1)	**Mjoelner** RXIM	**UEM** RXIINN	Nominal Voltage swing				V	
RXQINP RFCONV(2)	**Mjoelner** RXQP	**UEM** RXQINP	Input DC level	1.3	1.35	1.4	Vdc	
			Signal frequency		67,7		KHz	
RXQINN RFCONV(3)	**Mjoelner** RXQM	**UEM** RXQINN	Input BW			270.83	KHz	

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Table 15: RF-BB-Interface Aanlog Signals

Signal name	From	To	Parameter	Min	Typ	Max	Unit	Notes
TXIOUTP RFCONV(4)	**UEM** TXIOUTP	**Mjoelner** TXIP	Max Differential output swing (ref. TxIN)	2.15	2.2	2.25	Vpp	Differential complex TX signal (programable voltage swing)
TXIOUTN RFCONV(5)	**UEM** TXIOUTN	**Mjoelner** TXIN	Input diff. Swing (ref. TxIN)		1.0		Vpp	
TXQOUTP RFCONV(6)	**UEM** TXQOUTP	**Mjoelner** TXQP	DC level	1.0	1.1	1.25	Vdc	
TXQOUTN RFCONV(7)	**UEM** TXQOUTN	**Mjoelner** TXQN	Source impedance			200	Ω	
			Signal frequency		67,7		KHz	
RFAUXCONV(2:0)			**RF / BB analogue control signals**					
TXC RFAUXCONV(0)	**UEM** AUXOUT	**Mjoelner** TXC	Output voltage	0 - 0.1		2,4 - 2.55	V	Transmitter power control
			Source impedance			200	Ω	
			Resolution	10			Bits	
			Reference	Auxref (VrefRF01 ?)				
			Power coef. Range.	0,05		0,94	Vtxc/ Vtxc_max	
			Recom. Power Coef.1 @ pwr.lvl.5 (0 pcn)	0,7		0,9	Vtxc/ Vtxc_max	
			Recom.Power Coef. @ pwr.lvl.19 (15 pcn)	0,1		0,2	Vtxc/ Vtxc_max	
			Recom.Power Coef @ Base level	0,1		0,2	Vtxc/ Vtxc_max	

Voltage Regulators in BB for RF

Values are refenced to GND unless otherwise specified.

Table 16: Voltage Supplies and References

Signal name	From	To	Parameter	Min	Typ	Max	Unit	Notes
Regulators			**RF regulators**					
VR1A	**UEM** VR1A	**Mjoelner** VDDCP	UEM Output Voltage	4.6	4.75	4.9	V	Supply to : Charge pump
			Mjoelner Input Voltage	2.64	2.78	4.9	V	
			UEM output Load Current	0	(3)	5	mA	
			UEM Load Capacitance	800	1000	1200	nF	
				20		600	mΩ	ESR
			Settling Time		$300+t_{d2}$		µs	Sleep to Active
VR2	**UEM** VR2	**Mjoelner** VDDTX VDDDIG	UEM Output Voltage	2.70	2.78	2.86	V	Supply to TX - chain Modulator digital contl logic
			Mjoelner Input Voltage	2.64	2.78	2.86	V	
			Load Current	0.1	3)	100	mA	
			Load Capacitance	800	1000	1200 (4)	nF	
				20		600	mΩ	ESR
			Settling Time	10			µs	Sleep to Active

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Table 16: Voltage Supplies and References

Signal name	From	To	Parameter	Min	Typ	Max	Unit	Notes
VR3	**UEM** VR3	**Mjoelner** VDDXO VDDBBB	UEM Output Voltage	2.70	2.78	2.86	V	Supply to : XO and base-band buffer
			Mjoelner Input Voltage	2.64	2.78	2.86	V	
			Load Current	0.1	(3)	20	mA	
			Load Capacitance	800	1000	1200 (4)	nF	
				20		600	mΩ	ESR
			Settling Time			50	µs	Off to on
				10 ?			µs	Sleep to Active
VR4	**UEM** VR4	**Mjoelner** VDD?RXBB	UEM Output Voltage	2.70	2.78	2.86	V	Supply to : RX baseband section
			Mjoelner Input Voltage	2.64	2.78	2.86	V	
			Load Current	0.1	(3)	100	mA	
VR5	**UEM** VR5	**Mjoelner** VDDPRE VDDLO VDDPLL	UEM Output Voltage	2.70	2.78	2.86	V	Supply to : Prescaler, devi-ders, LO buffers, PLL counters
			Mjoelner Input Voltage	2.64	2.78	2.86	V	
			Load Current	0.1	(3)	50	mA	
			Load Capacitance	800	1000	1200 (4)	nF	
				20		600	mΩ	ESR
			Settling Time	10			µs	Sleep to Active
VR6	**UEM** VR6	**Mjoelner** VDDRXF	UEM Output Voltage	2.70	2.78	2.86	V	Supply to : RX frontend
			Mjoelner Input Voltage	2.64	2.78	2.86	V	
			Load Current	0.1	(3)	50	mA	
			Load Capacitance	800	1000	1200 (4)	nF	
				20		600	mΩ	ESR
			Settling Time	10			µs	Sleep to Active
VR7	**UEM**	**VCO**	UEM Output Voltage	2.70	2.78	2.86	V	Supply to : VCO
			VCO supply voltage range[2]	2.55	2.78	2.85	V	
			Load Current	0.1	(3)	45	mA	
			Load Capacitance	800	1000	1200	nF	
				20		600	mΩ	ESR
			Settling Time	10			µs	Sleep to Active
VIO	**UEM** VIO	**Mjoelner** VDDDL	UEM Output Voltage	1.72	1.88	1.88	V	Supply to: RF-BB inter-face level shifter
			Mjoelner Input Voltage	1.71	1.8	1.88	V	
			Load Current	0.1	(3)	5(3)	mA	
			Load Capacitance					
			Settling Time					
References			**RF References**					
VREF1	**UEM** VREF01	**Mjoelner** VBEXT	UEM Output Voltage	1.334	1.35	1.366	V	Used inside MJOELNER as 1.35V refer-ence
			Mjoelner Input Voltage	1.325	1.35	1.375	V	
			Load Current		(3)	100	mA	
			Load Capacitance	800	1000	1200	nF	
			Settling Time				µs	Sleep to Active

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System Connector Interface

System Connector

The system connector in RH-4 (and several other DCT-4 products) is called Pop-Port System Connector (unofficial name: "Tomahawk"). It is a galvanic interface between phone and accessories.

Compared with previous system connector versions, four new functions are introduced with the Pop-port system connector interface:

- Accessory Control Interface (ACI)
- Power Out
- Stereo audio output
- Universal Serial Bus (USB).

USB functionality and stereo audio output of the Pop-port are not supported in RH-4.

Note: MBUS function, (included in previous accessory interfaces, e.g. DCT-3) is no more supported by Pop-port interfaces.

Pop-port system connector is **mechanically and electrically not backward compatible** with any earlier Nokia accessory interfaces, except the charger connector.

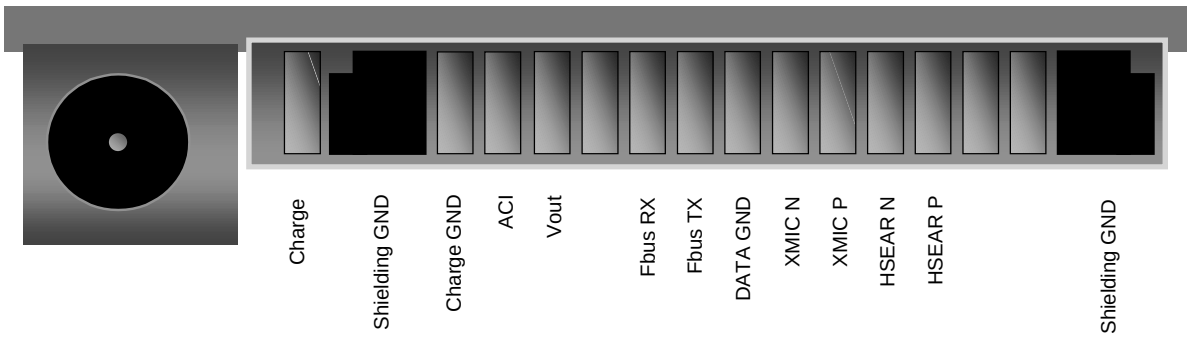

Figure 18: Pop Port System Connector

Table 17: System connector interface description

Pin #	Signal	Notes
1	VCHAR	
2	GND	Charge ground
3	ACI	Insertion & removal detection / Serial data bi-directional 1 kbit/s
4	Vout	
5		Not used in RH-4
6	FBUS_RX	Serial data from accessory to phone / 115 kbit/s
7	FBUS_TX	Serial data from phone to accessory / 115 kbit/s
8	GND	Data ground
9	XMIC N	Negative audio in signal
10	XMIC P	Positive audio in signal

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Table 17: System connector interface description

Pin #	Signal	Notes
11	HSEAR N	Negative audio out signal. Max bandwidth from the phone
12	HSEAR P	Positive audio out signal. Max bandwidth from the phone
13		Not used in RH-4
14		Not used in RH-4

Accessory Control Interface (ACI)

ACI is a point-to-point, master-slave, and bi-directional serial bus. It has three features:

- The insertion and removal detection of an accessory device
- Acting as a data bus, intended mainly for control purposes
- The identification and authentication of accessory type which is connected

The accessories are detected by the HeadInt signal when the plug is inserted.

Normally when no plug is present, the pull-up resistor 100k pulls up the HeadInt signal to VFLASH1. If the accessory is inserted, the external "insertion & removal" resistor works as voltage divider and decrease the voltage level below the threshold Vhead.

Thereby the comparator output will be changed to high state causing an interrupt.

If the plug is removed, the voltage level of HeadInt increases again to VFLASH1. This voltage level is higher than the threshold of the comparator and thereby its output will be changed to low. This changes is leading to an interrupt.

These HeadInt interrupts are initiated the accessory detection or removal sequence.

If no accessory inserted / connected the only active part on the Pop-port interface is the ACI line.

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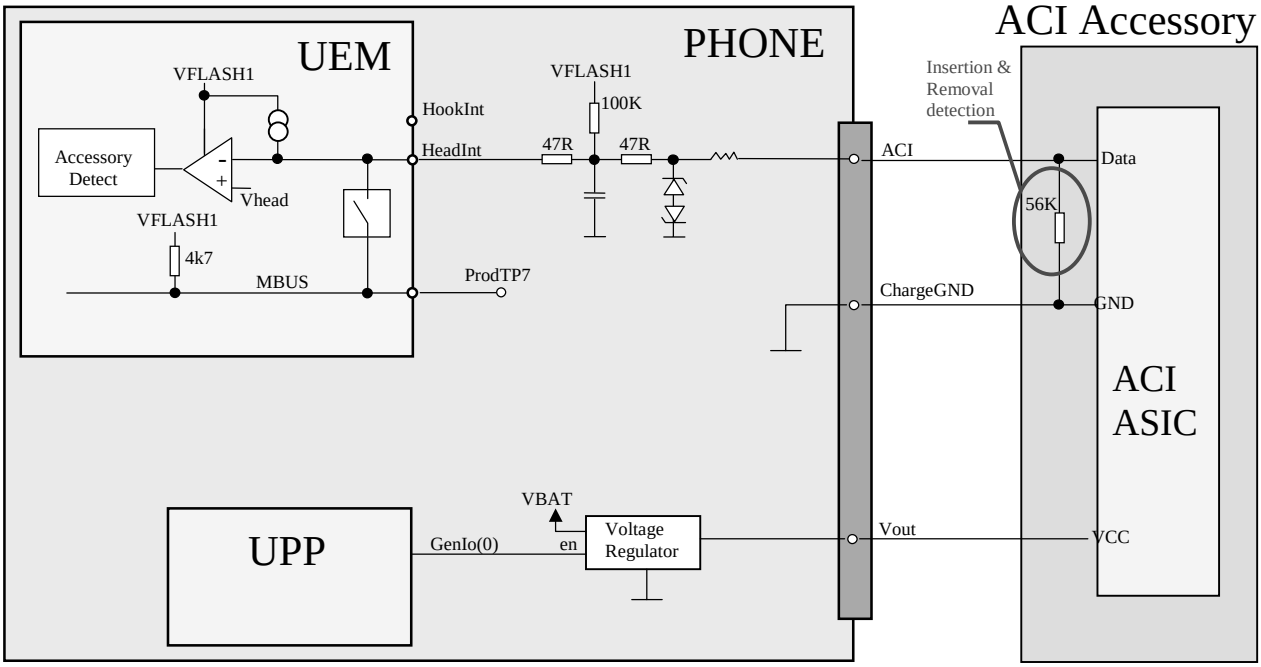

Figure 19: Principle schematics of ACI Accessory and engine

Signal flow on ACI line - ACI-ASIC accessory inserted

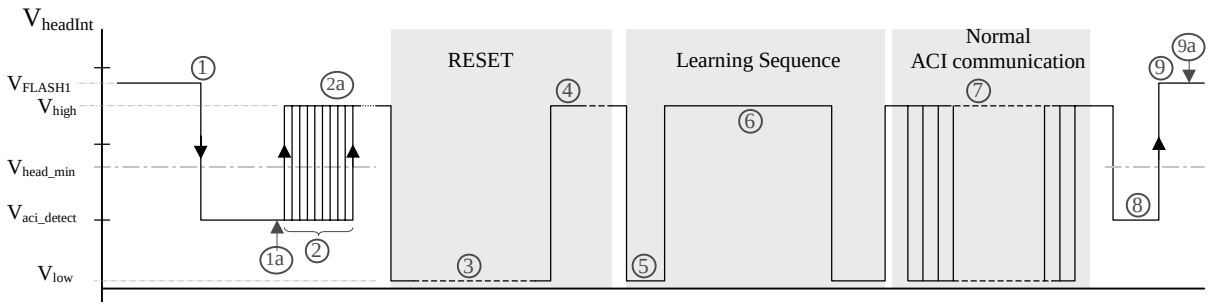

Figure 20: ACI communication

1. Accessory is connected (insertion & removal resistor connect to ACI line)

1a) phone gets HeadInt interrupt after 20ms check that ACI line is still low (<Vhead min)

2. Connect MBUS with HeadInt line (MBUS switch)

2a) If the phone detect a HeadInt interrupt from low to high transition in 20ms time-frame, then an advanced accessory is connected

3. ACI chip reset (3000- 4000us)

4. Power up delay (50-400us)

5. Start bit (50us)

6. Learning sequence (567-1700us)

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7. ACI communication

8. MBUS is disconnected from HeadInt line (MBUS switch). After every communication.

9. Accessory is removed (no insertion & removal resistor on ACI line) --> phone gets HeadInt interrupt from ACI line low to high transition.

9a) If no HeadInt interrupt comes in the next 100ms the accessory is really removed and the phone goes in the state "no accessory".

Table 18: Voltage Levels

Signal	Min	Typ	Max	Unit	Note
V_{FLASH1}	2.7	2.78	2.86	V	
V_{head}	1.75	1.9	2.05	V	
Specified values for levels	**Min**	**Typ**	**Max**	**Unit**	**Note**
V_{ACI_detect}	0.83		1.13	V	Voltage level if MBUS not connected to HeadInt (MBUS switch open), but ACI accessory is inserted.
V_{high}	2.45		2.71	V	Voltage level after MBUS connected to HeadInt.
V_{low}		<0.22*VDD		V	

Signal flow on ACI line - Non ACI-ASIC accessory inserted

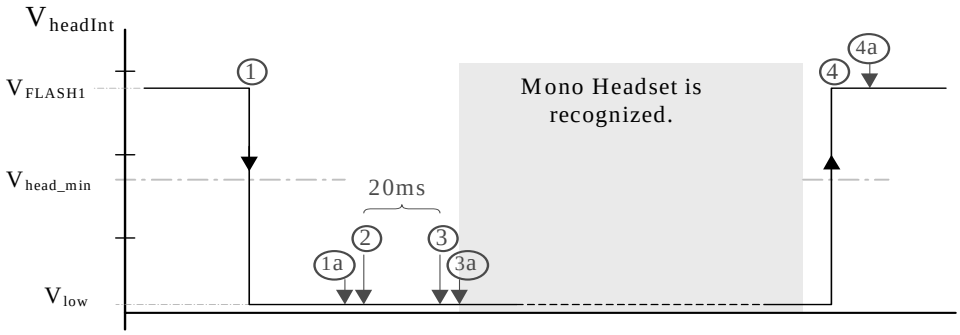

Figure 21: Signal flow on ACI Line

1. Accessory is connected (insertion & removal resistor connect to ACI line)

1a) phone gets HeadInt interrupt after 20ms check that ACI line is still low (<Vhead min)

2. Connect MBUS with HeadInt line (MBUS switch)

3. The 20 ms timer elapsed and no transition has been on HeadInt line

3a) Disconnect MBUS from HeadInt line

4. Accessory is removed. Phone gets HeadInt interrupt from ACI line low to high transition.

4a) If no HeadInt interrupt comes in the next 100ms the accessory is really removed.

FBUS

FBUS is an asynchronous data bus with separate TX and RX signals. Default bit rate of the bus is 115.2 Kbit/s.

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FBUS is used as additional communication channel from phone to accessory and vice versa. There is two types of accessories which it uses:

1. Nokia Serial Bus Accessory, AT mode
2. Fbus Phonet mode accessory

From HW-point of view, this does not make any difference.

Table 19: FBUS interface

Signal	Parameter	Min	Typ	Max	Unit
FBUS_RX	V_{IH}	1.95	2.78	3.0	Volt
	V_{IL}	0	0.2	0.83	
FBUS_TX	V_{OH}	1.95	2.78	2.83	
	V_{OL}	0	0.2	0.83	

VOUT (Accessory Voltage Regulator)

DCT4 chip set does not provide and power supply for accessories. To enable this an external LDO regulator is needed. This regulator is called "Accessory Regulator".

The regulator input is connected directly to battery voltage VBAT and the output to VOUT pin at system connector. The regulator is controlled by the GENIO(0) line of UPP. With this signal the regulator can be switched on and off.

The regulator can be supply up to150 mA. (note: this exceeds the Pop-port minimum requirement.)

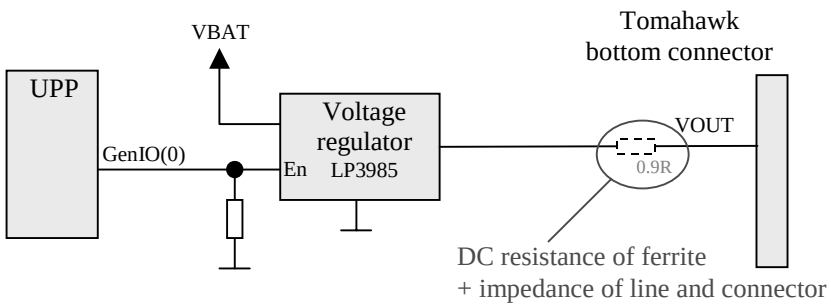

Figure 22: Accessory Power Supply Diagram

Table 20: Accessories Power Supply

Signal	Min	Nom	Max	Unit	Note
Vout	2.63 2,56	2.80	2.88	V	I = 70mA Imax = 150mA
GenIO(0)	1.4	1.88 0.6	0.6	V	High (ON) Low (OFF)

The pull-down resistor on the enable input of the regulator is needed because in the switch-off mode of the phone, the output level of the Genio(0) is not defined. Without this resistor's the output of the regulator can be floating.

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RH-4 supports fully differential external audio signals. A headset can be connected to the Pop-port system connector. However, only Mono audio is supplied to accessories.

HookInt

This signal is used to detect whether a button in accessory is pressed or not. The hook signal is generated by creating a short circuit (20 ohm) between the headset microphone signals (XMICP and XMICN). In this case, an LP-filter is needed on the HookInt input to filter the audio signal.

If no accessory is present, the HookInt signal is pulled up by the UEM resistor.

If an accessory inserted and the microphone path is biased the HookInt signal decreases to 1.9V due to the microphone bias current flowing through the resistor. When the button is pressed the microphone signals are connected together, and the HookInt input will get half of micbias dc value 1.1V. This change in DC level will cause the HookInt comparator output to change state, in this case from 0 to 1.

HookInt comparator reference is selected level is 1.35 V.

Normally micbias and hookint are enabled only when audios are routed to headset.

In order to recognize the Hook signal (button in headset or SyncButton in deskstand), during the phone is in the sleep mode, it must be done by polling. That means the micbias and the hookInt signal must be enabled in regular time intervals.

Table 21: Voltage Levels Hook Int

Signal	Min	Nom	Max	Unit	Note
VFLASH1	2.7	2.78	2.86	V	
MICB2	2.0	2.1	2.25 600	V uA	
Vhook1	1.25	1.35	1.45	V	

Charging

RH-4 can be charged via a DC-plug or charging pins on the system connector. Furthermore, it supports only 2-wire charging.

DC-Plug

Like most Nokia phones, RH-4 uses a 3.5mm DC-plug. Nevertheless, it is possible to use a 3-wire charger, but the PWM inside these chargers is not supported.

VCHAR Pins of System Connector

The VCHAR and ChargeGND pin are directly connected to the normal charger lines of the DC-plug.

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Table 22: Charger Input Voltage Levels

Signal	Min	Nom	Max	Unit	Note
Input voltage range (fast charger)	5.5	8.4	9.3	VRMS	I= 850mA
Input voltage range (standard charger)		11.1 7.9	16	Vpeak VRMS	
	-0.3		20	V	Absolute maximum VHAR voltage

Voltages and Currents

Table 23: System connector interface signals

Pin #	Signal	Parameter	Min	Typ	Max	Unit	Notes
1	VCHAR		0		9 0.85	VDC ADC	
2	GND						Charge ground
3	ACI	Logic "0"	0	0.2	0.7	V	Insertion & removal detection / Serial data bi-directional 1 kbit/s
		Logic "1"	1.7	2.78	2.86		
4	Vout	Output voltage	2.56	2.8	2.88	VDC	70mA is specified as the max. current in the Pop-port specification
		Current		70	150	mA	
5							Not used in RH-4
6	FBUS_RX	Logic "0"	0	0.2	0.86	V	Serial data from accessory to phone / 115 kbit/s
		Logic "1"	2.0	2.78	3.0		
7	FBUS_TX	Logic "0"	0	0.2	0.81	V	Serial data from phone to accessory / 115 kbit/s
		Logic "1"	1.89	2.78	2.83		
8	GND						Data ground
9	XMIC N	Differential voltage swing		1		Vpp	Negative audio in signal
		DC level	?	?	?	VDC	
10	XMIC P	Differential voltage swing		1		Vpp	Positive audio in signal
		DC level	2.05	2.1	2.25 400	VDC uA	
11	XEAR N	Differential voltage swing	1			Vpp	Negative audio out signal. Max bandwidth from the phone
12	XEAR P	Differential voltage swing	1			Vpp	Positive audio out signal. Max bandwidth from the phone
13							Not used in RH-4 (grounded)
14							Not used in RH-4 (grounded)

Baseband Calibration

Calibration for RH-4 must be done in LOCAL-mode.

Dispersion in UEM AD-converters and external components must be compensated.

ADC-converter calibration is made with two different calibration points.

- Connected 0.7V to BSI line -> read AD-converter value.
- Connected 2.1V to BSI line -> read AD-converter value.
- SAVE VALUE to PMM (Permanent Memory) area.

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BSI calibration is made in order to get correct battery information.

- Set to BSI line 1% 75kohm resistor -> read AD-converter value.
- SAVE VALUE to PMM (Permanent Memory) area.

VBATT calibration is made in order to get correct battery voltage.

- Set to VBATT line 3.1V and 4.2V -> read AD-converter value.
- SAVE VALUE to PMM (Permanent Memory) area.

VCHARGE calibration is made in order to get charger types and charger voltages correct.

- Connect 8.4V to charger line -> read AD-converter value.
- SAVE VALUE to PMM (Permanent Memory) area.

Charge current calibration is made order to get correct charge current.

- Connect 500mA to charger line -> read AD-converter value.

Calibration is easiest done by using JBV-1 box in conjunction with Phoenix Service SW.

BB Calibration Limits

Table 24: BB calibration limits

AD channel	**Min**	**Max**
ADC OFFSET	**-50**	**50**
ADC GAIN	25400	29000
BSI GAIN	860	1180
BTEM GAIN	1980	2280
BTEM GAIN (No calibration)	2127	2127
VBAT SCAL OFFSET	2300	2700
VBAT SCAL	10000	11000
VCHAR	58000	62000
ICHAR GAIN	3850	4650

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Baseband Testpoints

List and Description

Table 25: RH-4 test points

Signal	Test point	Function	Characteristics	Note
FBUSTX0	PRODTP2	Flash programming data and phone control	2.78V digital signal	From phone to FPS-8/PC
FBUSRX0	PRODTP3	Flash programming data and phone control	2.78V digital signal	From FPS-8/PC to phone
VPP	PRODTP6	Flash programming voltage	1.8V internal voltage	
			12V external voltage	
MBUS	PRODTP7	Flash programming clock and phone control	2.78V digital signal 6.5 MHz max.	Bi-directional phone control
BSI	J101 or battery connector	Battery size indicator Local mode indicator SIM removal indicator Flash programming start signal	1V in normal mode 0V in local mode If BSI line rises >2.1V 2.78 BSI pulse	To UEM A/D converter
SIMDATA	X387-6	SIM data	Digital signal 1.8/3V	From / to UEM / SIM card
SIMRST	X387-2	SIM reset	Digital signal 1.8/3V	From UEM to SIM card
SIMCLK	X387-1	SIM clock	3.25MHz digital clock signal 1.8/3V	From UEM to SIM card
VSIM	X387, pin3	Power supply for SIM card	1.8V or 3V	Depends on the SIM card
PURX	J402	Power up reset	1.8V digital signal	From UEM to UPP
SLEEPX	J403	Sleep mode control signal	1.8V when not in sleep 0V when in sleep mode	From UPP to UEM
SLEEPCLK	J404	Sleep mode timing clock	32.768kHz digital clock 1.8V	From UEM to UPP
UEMINT	J405	Interrupt request for UPP	1.8V digital signal	From UEM to UPP
CBUSCLK	J406	Serial control bus clock	1MHz digital clock signal 1.8V	From UPP (MCU) to UEM Controlled by MCU
CBUSDA	J407	Serial control bus data input/output	1.8V digital signal	Between UPP (MCU) and UEM Controlled by MCU
CBUSENX	J408	CBUS enable signal	1.8V digital signal	From UPP (MCU) to UEM Controlled by MCU
RFBUSDA	J422	Mjoelner control serial data	1.8V digital signal	From UPP to Mjoelner
RFBUSCLK	J421	Mjoelner control clock	13MHz digital clock signal 1.8V	From UPP to Mjoelner
RFBUSEN1	J423	Mjoelner chip select and latch enable	1.8V digital signal	From UPP to Mjoelner
RFCLK	R420	System clock for baseband	26MHz analog clock signal >300mVpp	From Mjoelner to UPP
RESX	J308-X302/2	LCD reset	1.8V digital signal	From UPP to LCD driver
CSX	J311-X300/5	LCD chip select	1.8V digital signal	From UPP to LCD driver
SDA	J310-X300/3	LCD serial data	1.8V digital signal	From UPP to LCD driver
SCLK	J309-X300/4	LCD clock	3.25MHz digital clock signal 1.8V	From UPP to LCD driver

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Table 25: RH-4 test points

Signal	Test point	Function	Characteristics	Note
TP_X+	J319(L320)	X-arm of touchpad		From touchpad to UPP
TP_X-	J318(L321)	X-arm of touchpad		From touchpad to UPP
TP_Y+	J320(L322)	Y-arm of touchpad		From touchpad to UPP
TP_Y-	J321(L323)	Y-arm of touchpad		From touchpad to UPP
MBUSTX	J409	MBUS from UPP to UEM	1.8V digital signal	
MBUSRX	J410	MBUS from UEM to UPP	1.8V digital signal	
FBUSTX	J411	FBUS from UPP to UEM	1.8V digital signal	
FBUSRX	J412	FBUS from UEM to UPP	1.8V digital signal	
DBUSCLK	J413	DBUS clock	13MHz digital clock signal 1.8V	From UPP (DSP) to UEM Generated by UPP
DBUSDA	J414	DBUS data input/output	1.8V digital signal	Between UEM and UPP (DSP)
DBUSEN!X	J415	DBUS selection and enable	1.8V digital signal	From UPP (DSP) to UEM
EXTWRX	J416	Flash memory write enable	1.8V digital signal	
EXTRDX	J417	Flash memory read enable	1.8V digital signal	
FLSCLK	J419	Flash memory clock	3.5MHz digital clock signal 1.8V	In burst mode
FLSCSX	J420	Flash memory chip select	1.8V digital signal	

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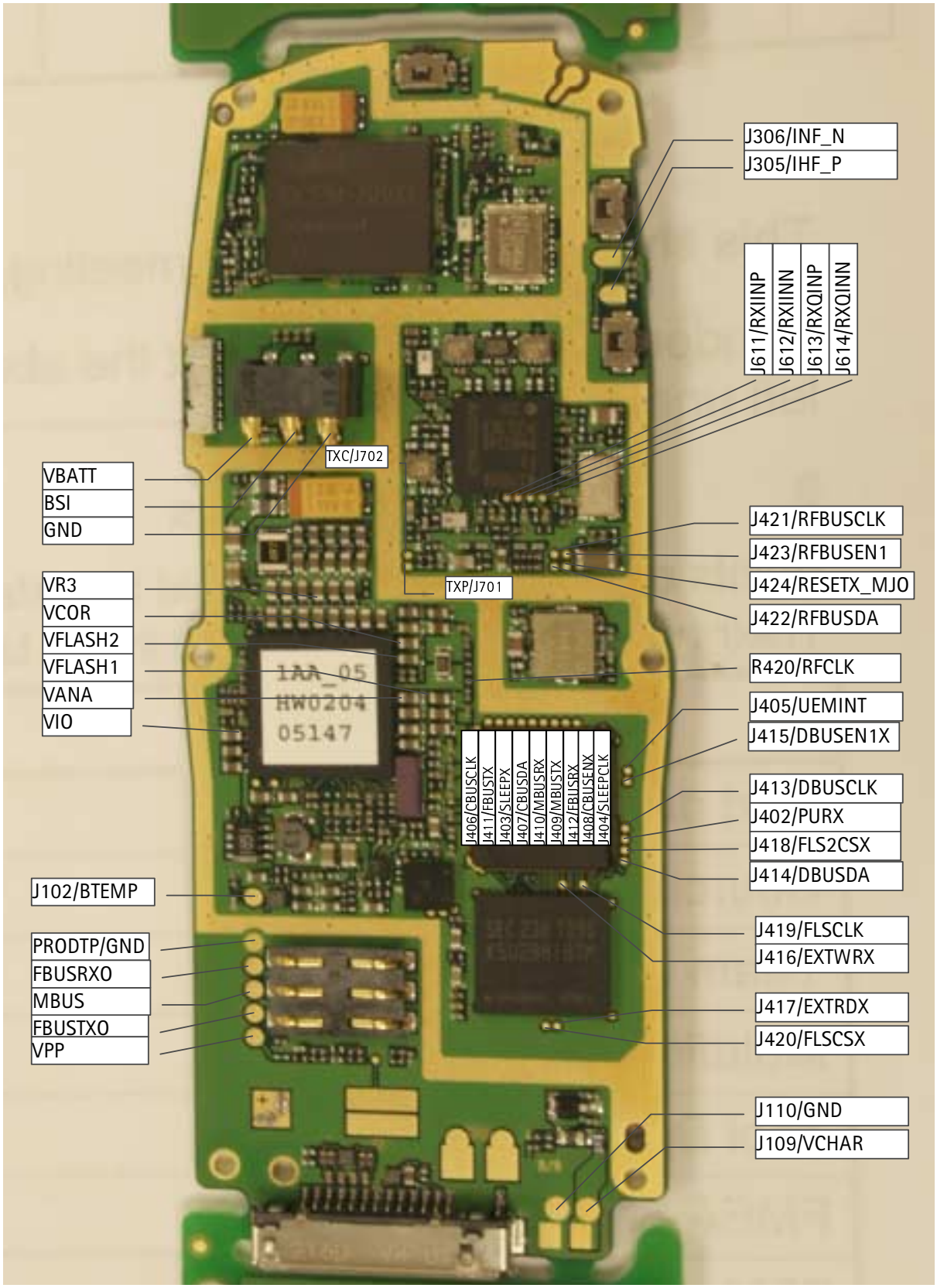
Testpoints on bottom-side



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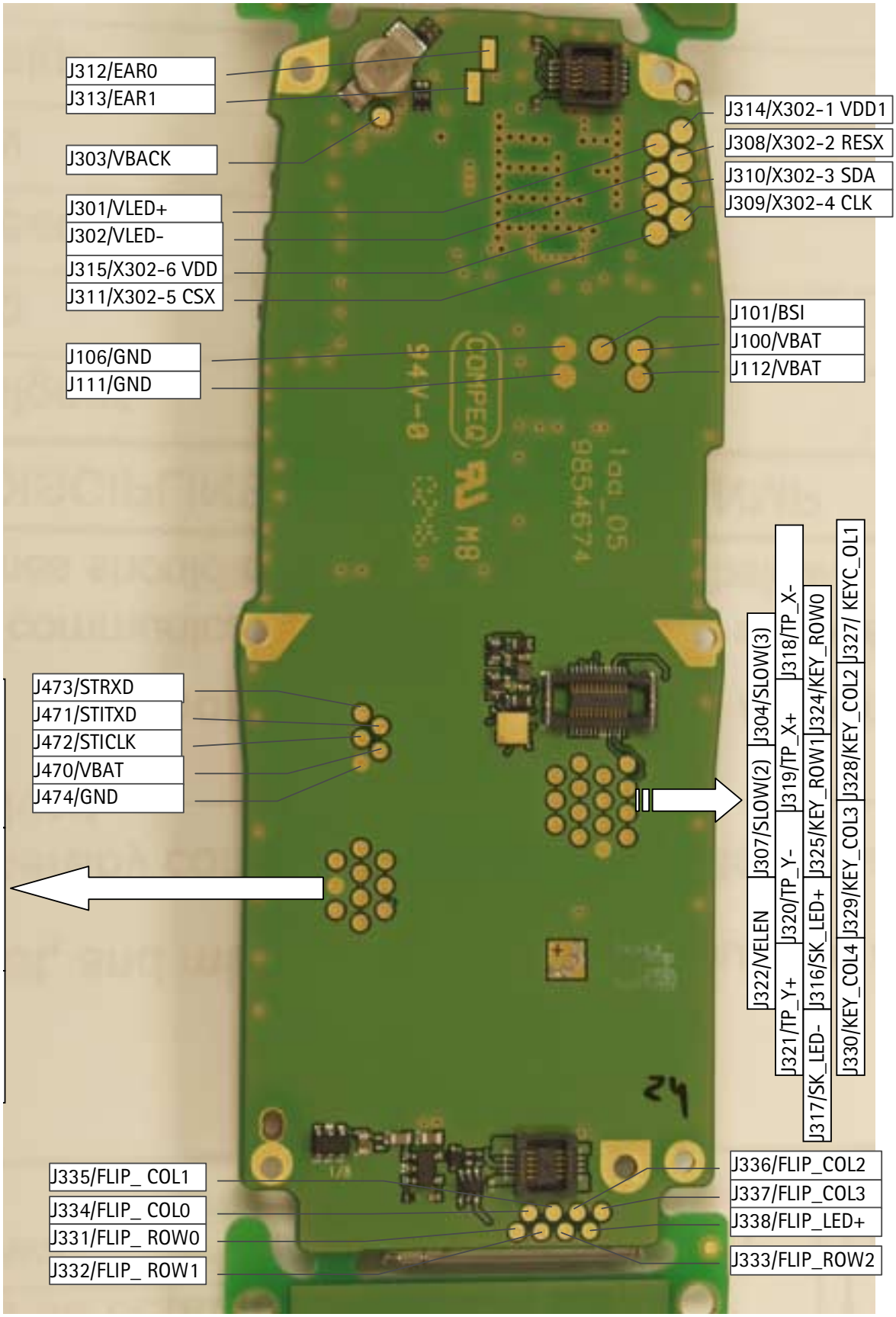
Testpoints on top-side



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Baseband Trouble Shooting

The following trouble shooting instruction is divided in to the following sections:

1 Phone is dead

2 Flash programming doesn't work

3 Phone is jammed

4 Charging fault

5 Plug in SIM card is out of order (insert SIM card)

6 Audio failure

7 Accessory detection problem

8 IrDA failure

9 UI failure

The first thing to do is carry out a through visual check of the module. Ensure in particular that:

a) there are no mechanical damages

b) solder joints appear OK

Secondly, try to reflash phone.

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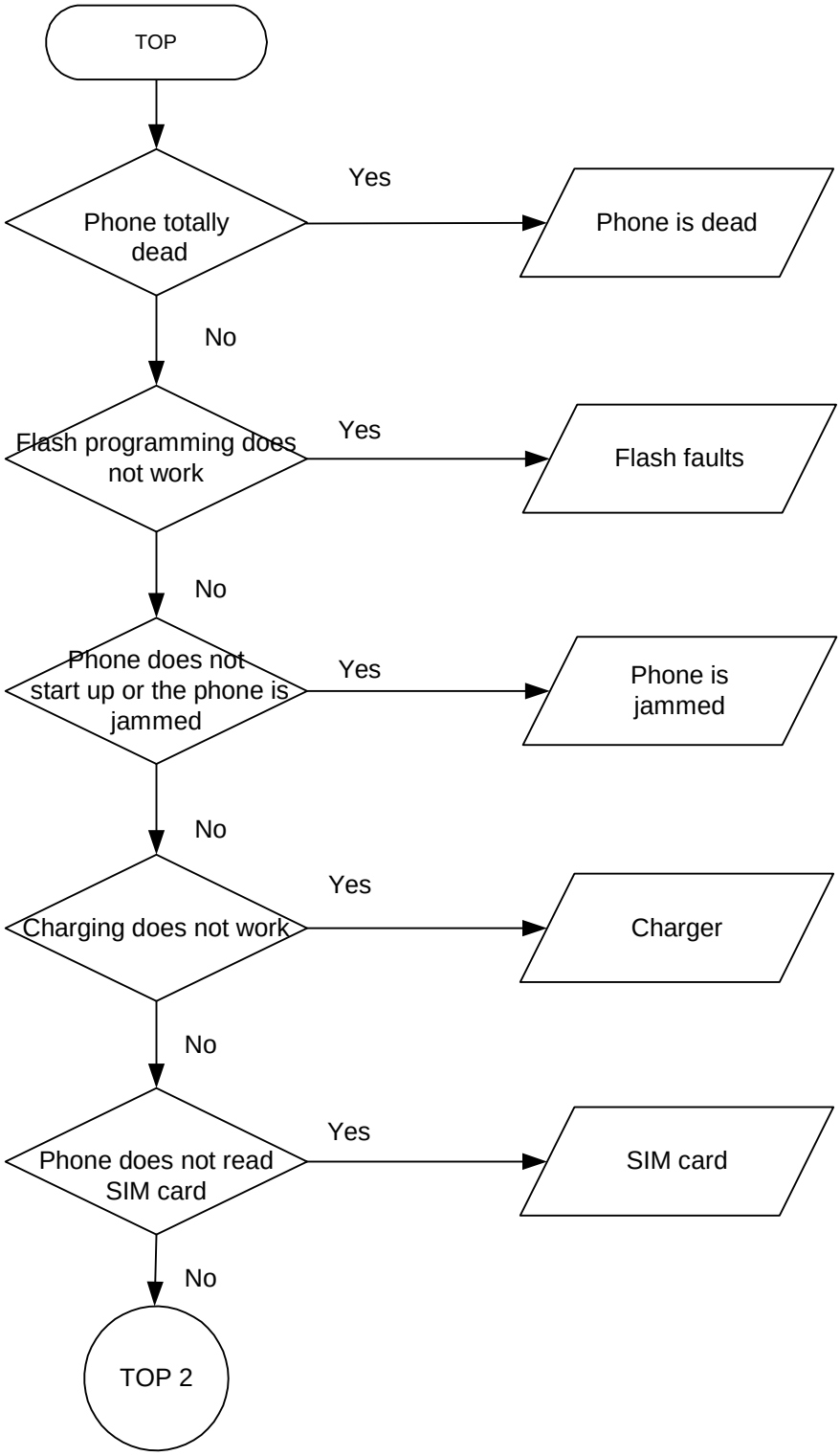
Top Level Flowchart



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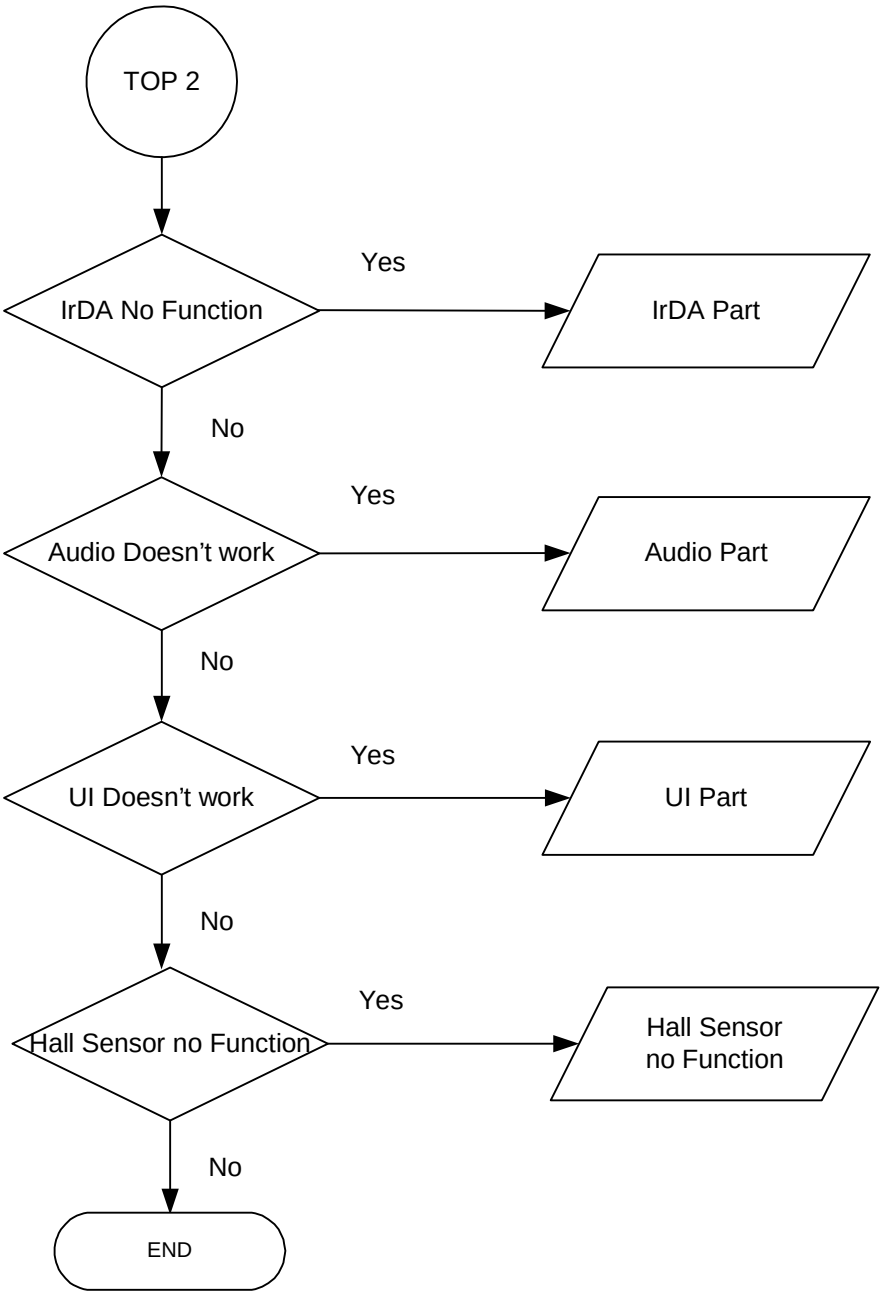

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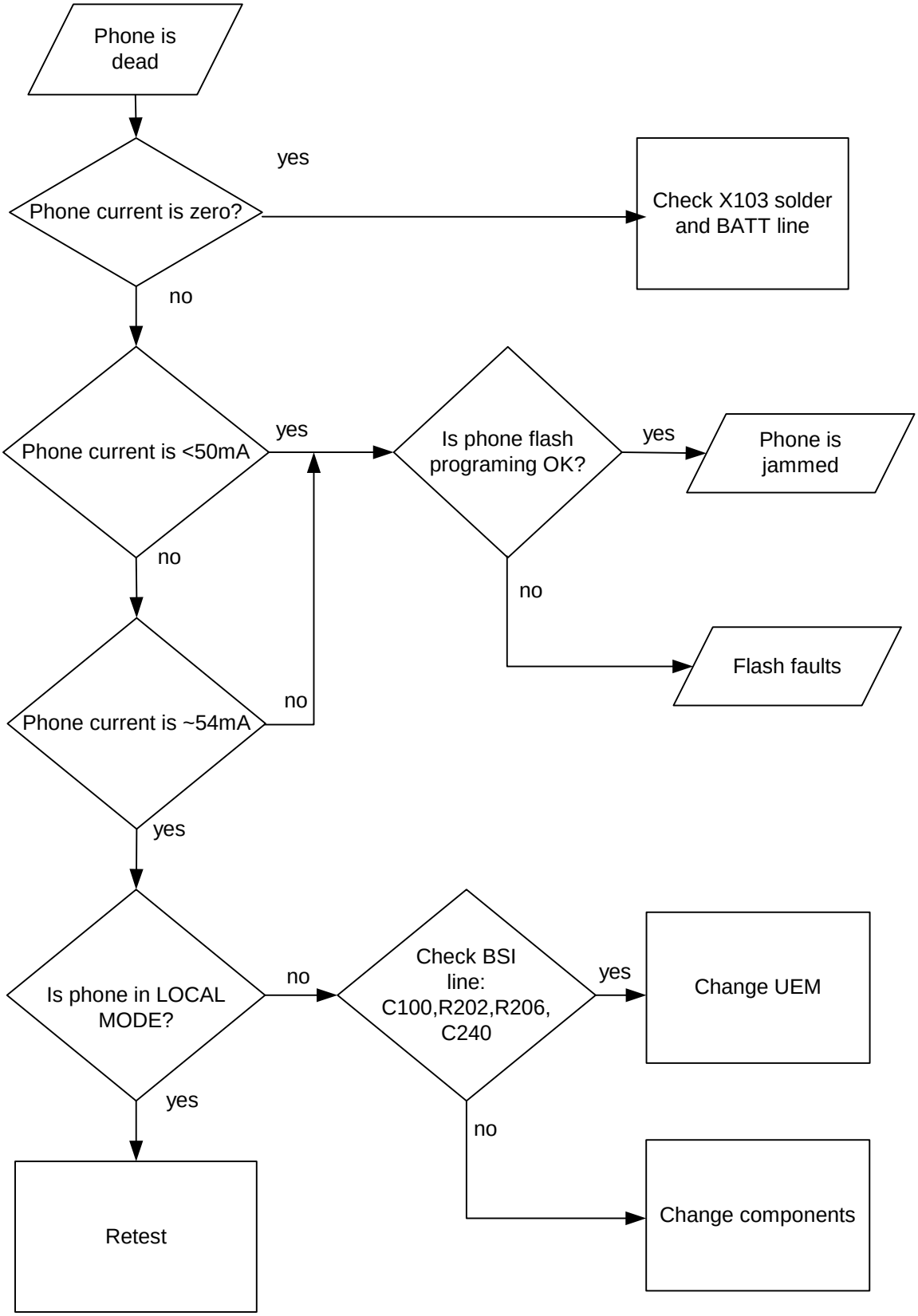
Phone is Dead



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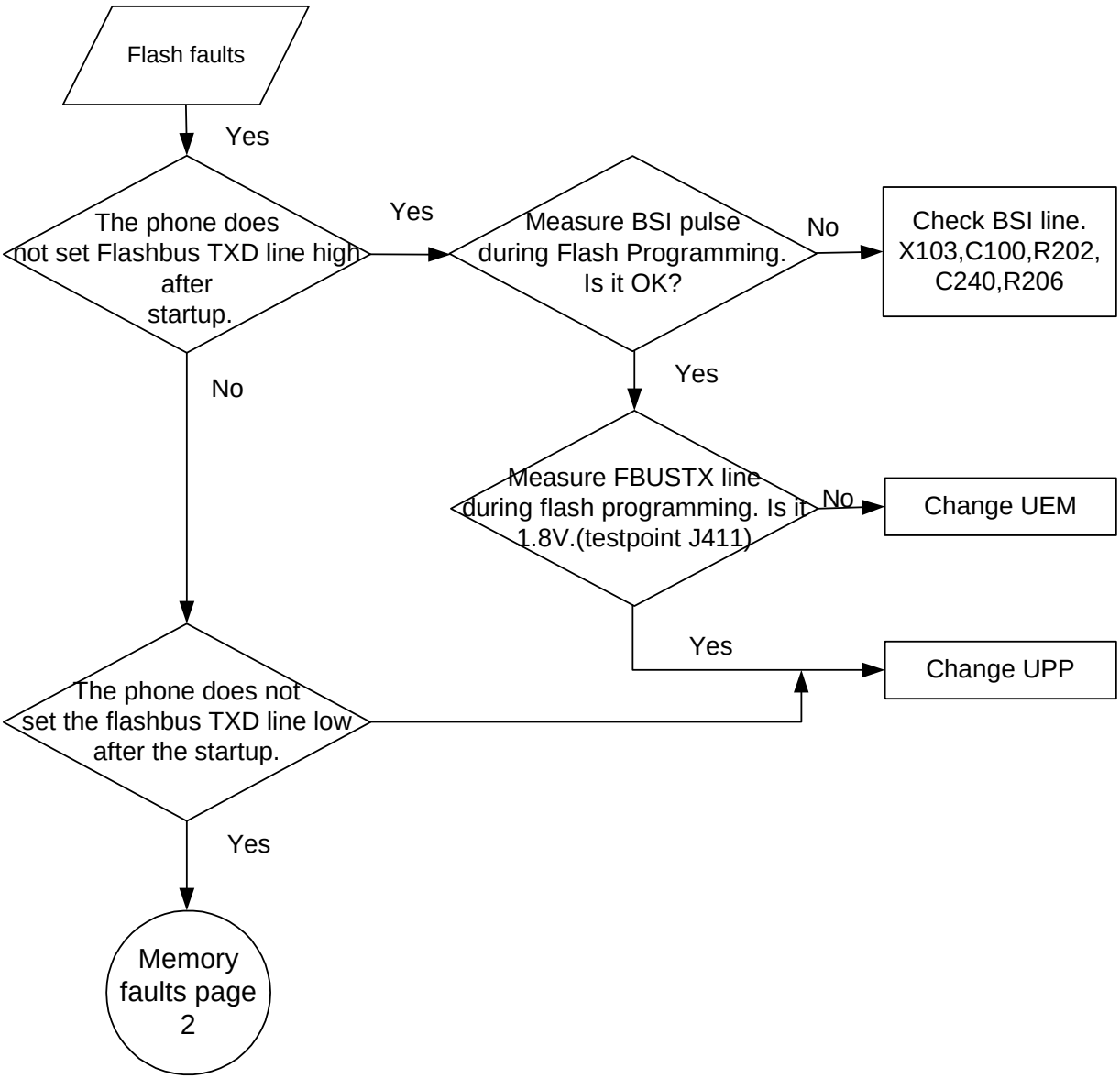
Flash Faults



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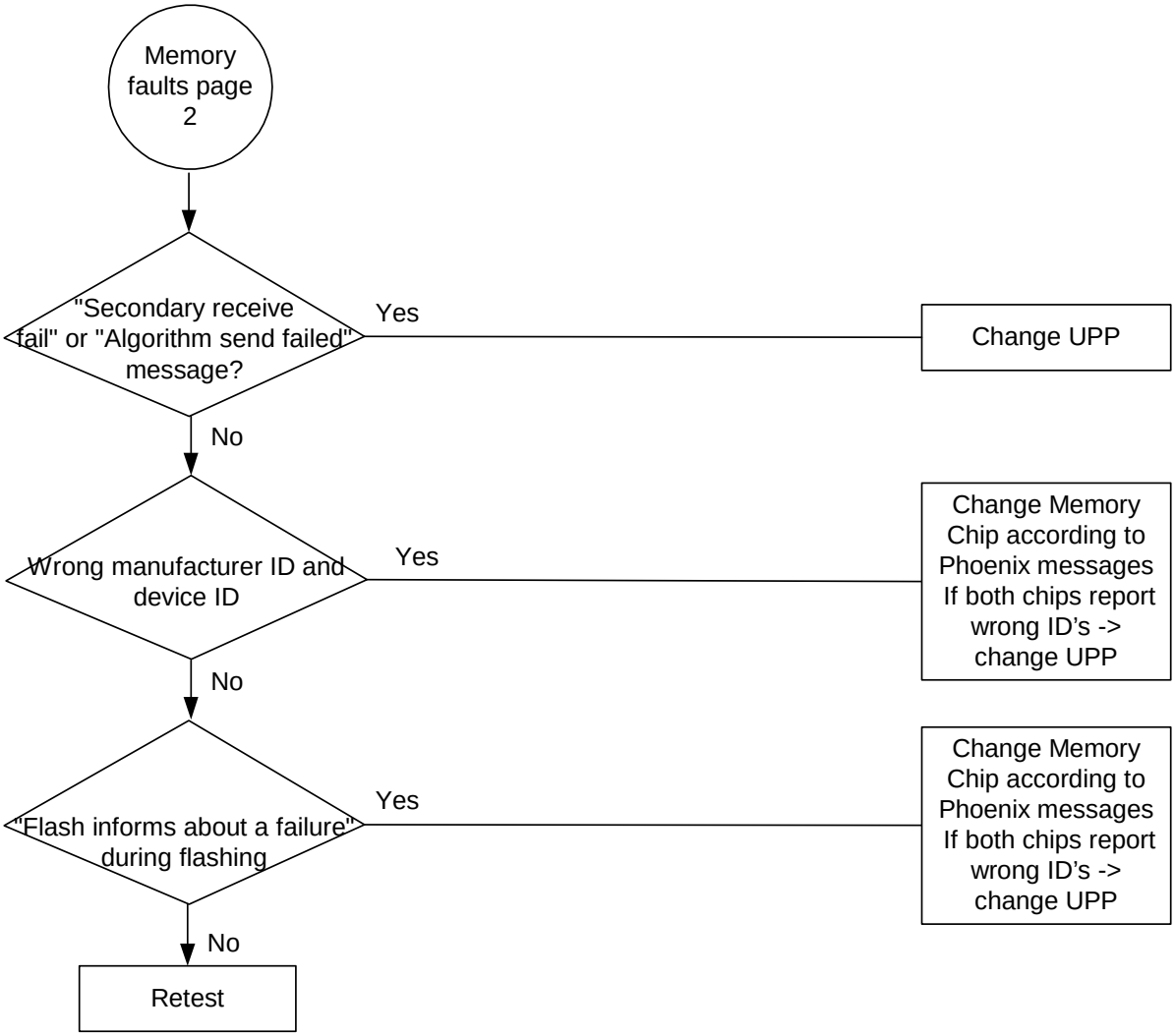
Memory faults page 2
"Secondary receive fail" or "Algorithm send failed" message?
Yes
Change UPP
No
Wrong manufacturer ID and device ID
Yes
Change Memory Chip according to Phoenix messages If both chips report wrong ID's -> change UPP
No
"Flash informs about a failure" during flashing
Yes
Change Memory Chip according to Phoenix messages If both chips report wrong ID's -> change UPP
No
Retest

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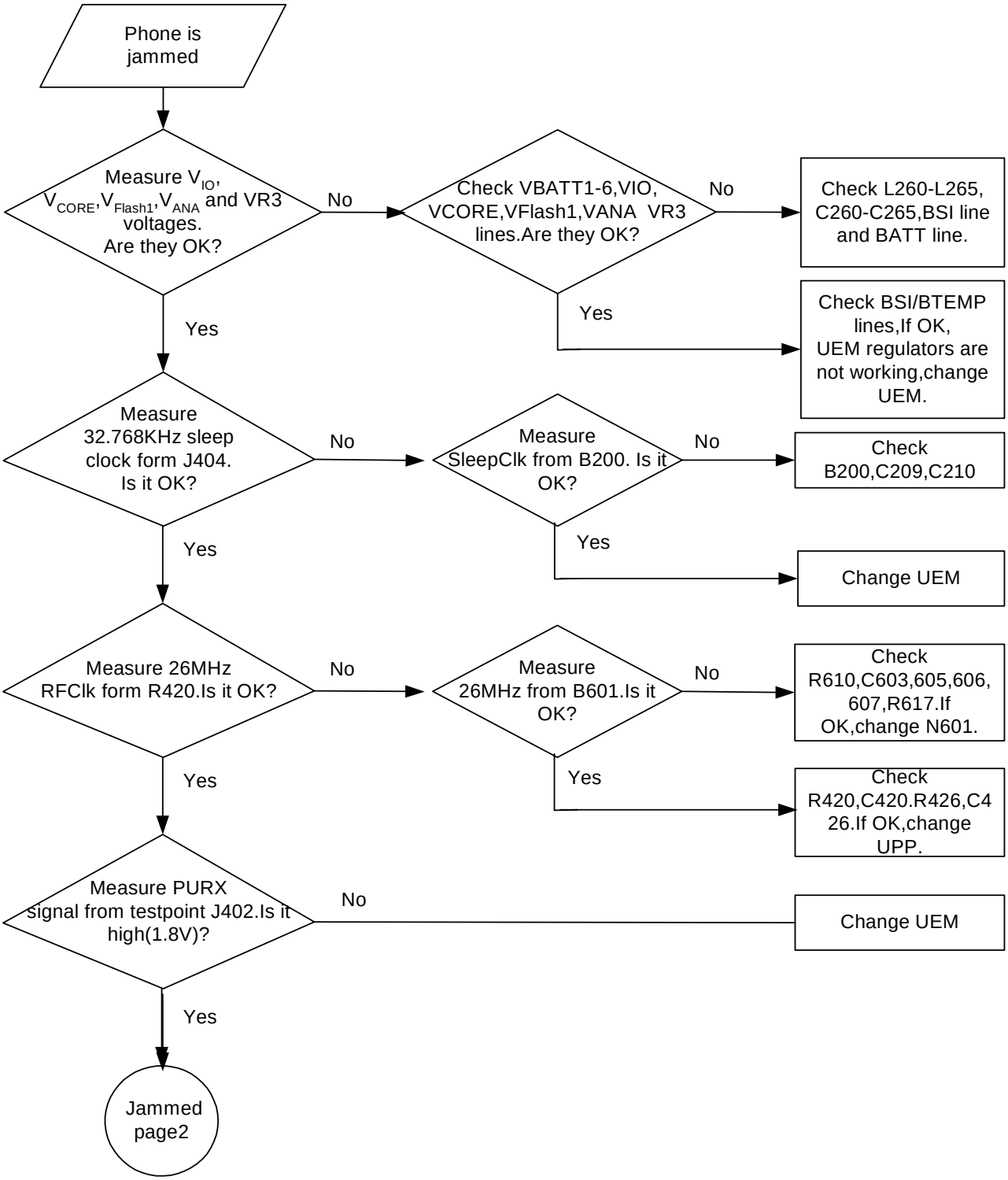
Phone is Jammed



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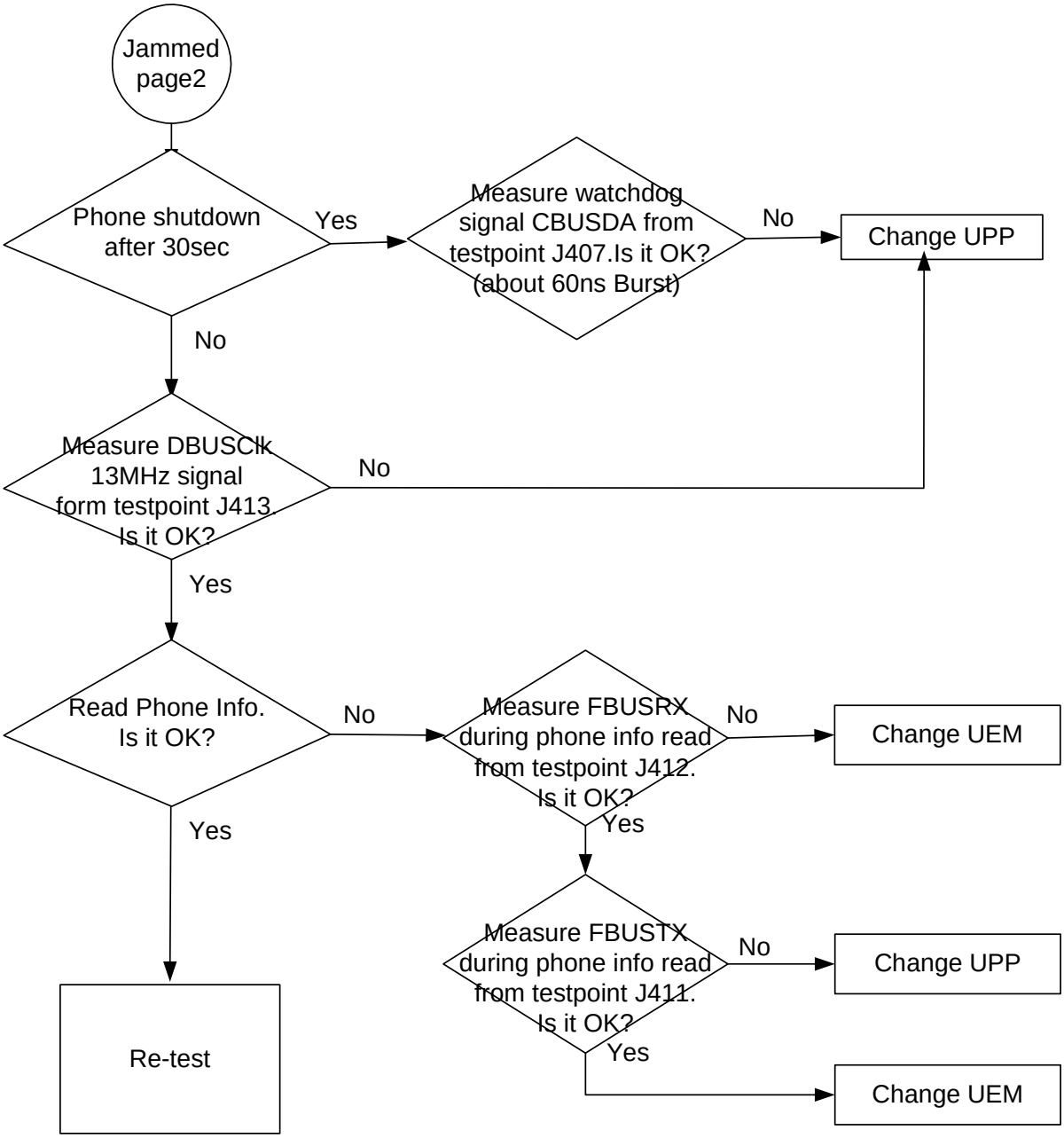

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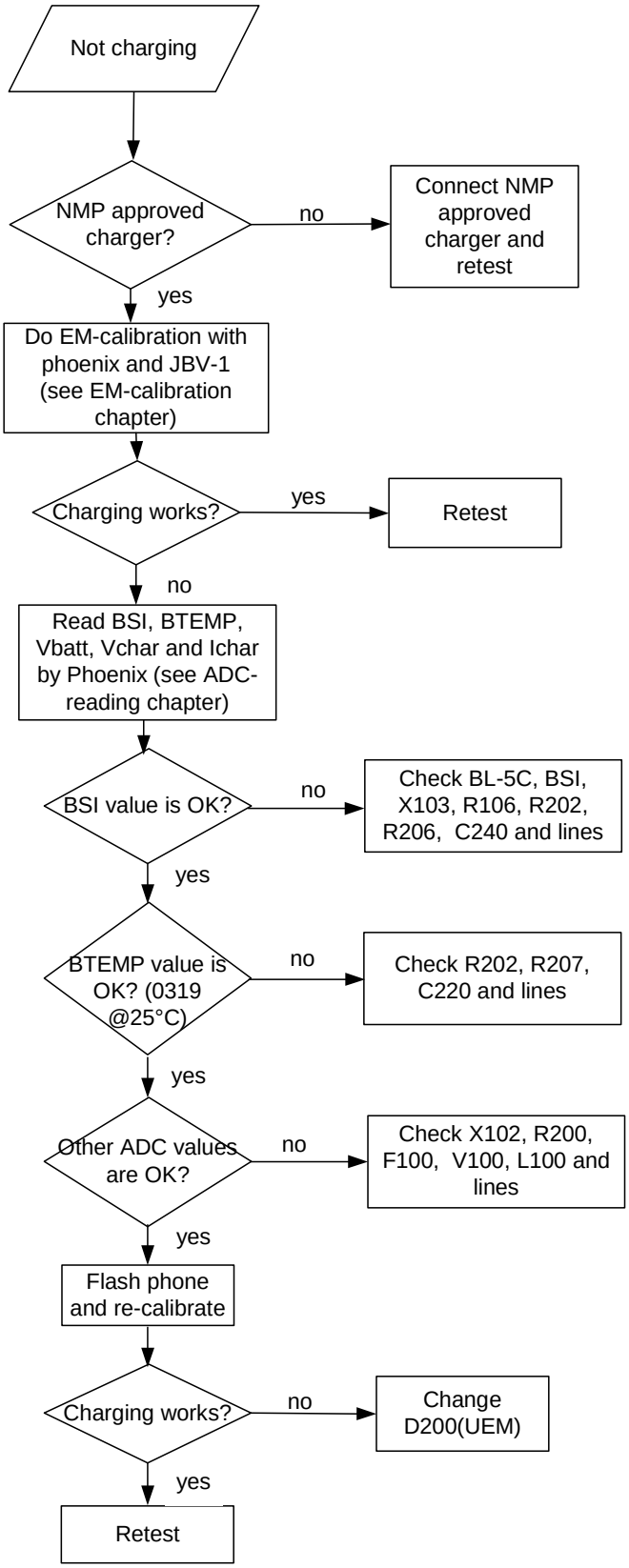
Phone does not Charge



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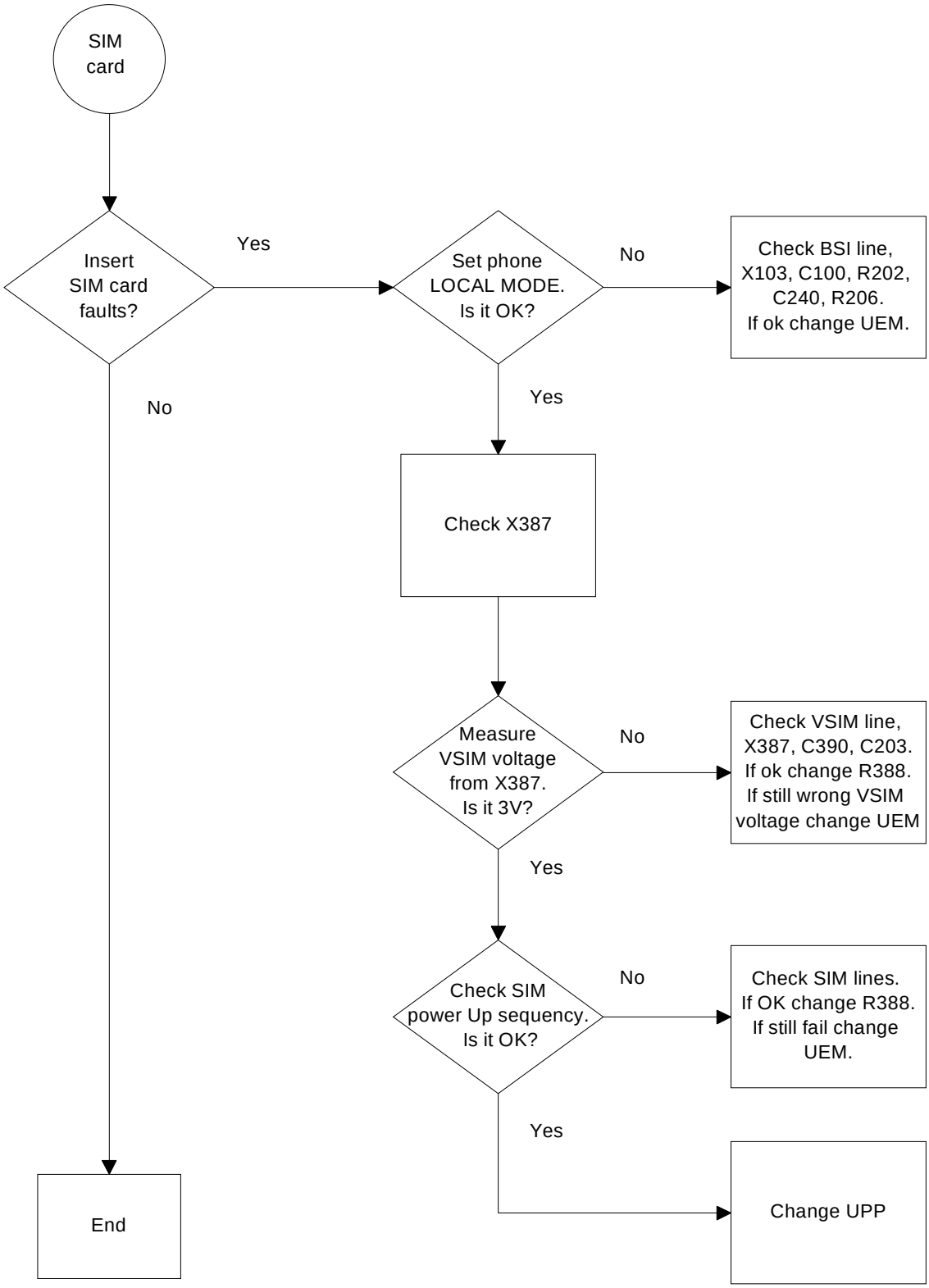
SIM Card Error


SIM card
Insert SIM card faults?
Yes
No
Set phone LOCAL MODE. Is it OK?
No
Check BSI line, X103, C100, R202, C240, R206. If ok change UEM.
Yes
Check X387
Measure VSIM voltage from X387. Is it 3V?
No
Check VSIM line, X387, C390, C203. If ok change R388. If still wrong VSIM voltage change UEM
Yes
Check SIM power Up sequency. Is it OK?
No
Check SIM lines. If OK change R388. If still fail change UEM.
Yes
Change UPP
End

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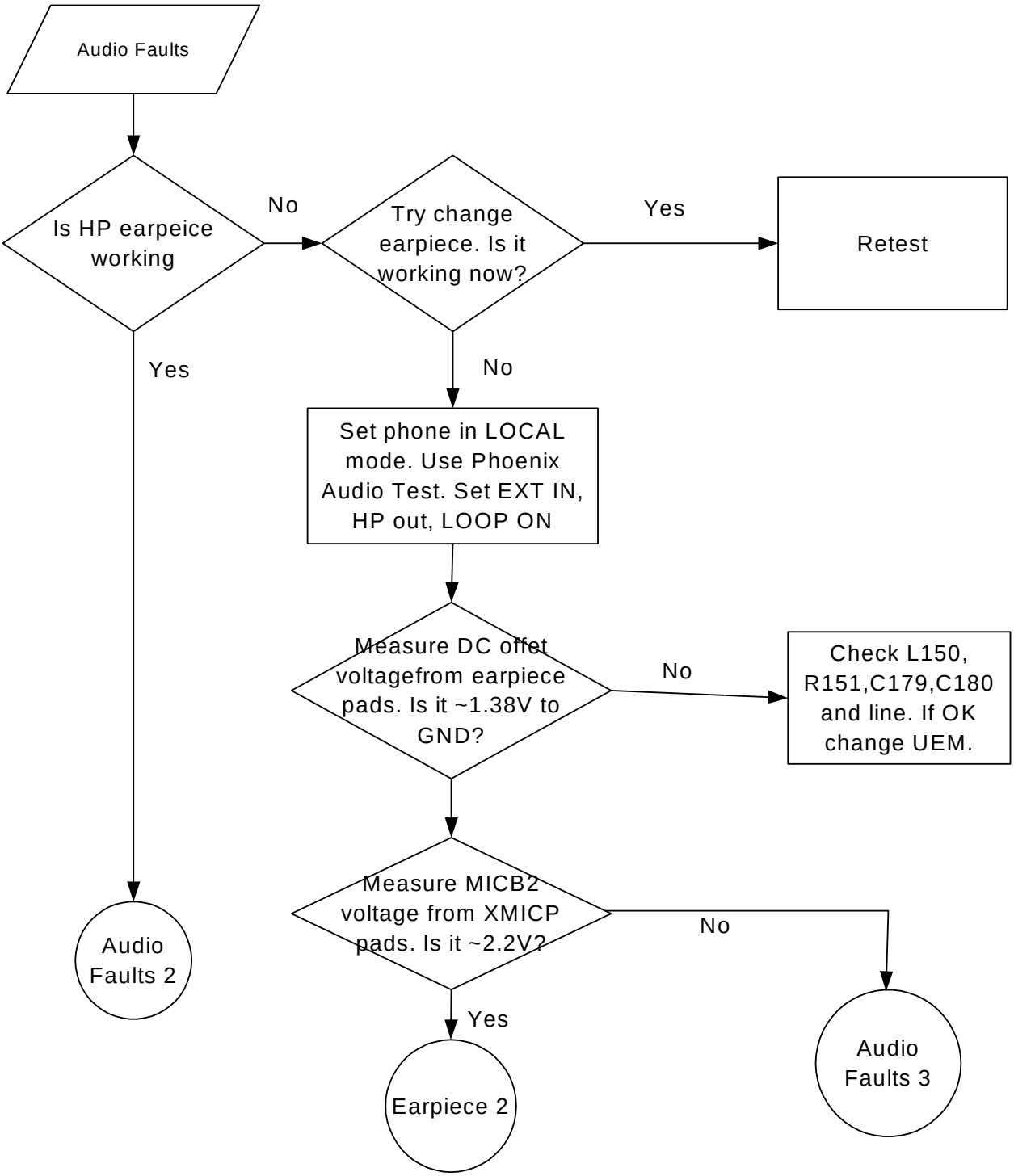
Audio Faults

HP earpiece failure


Audio Faults
Is HP earpeice working
No
Try change earpiece. Is it working now?
Yes
Retest
Yes
No
Set phone in LOCAL mode. Use Phoenix Audio Test. Set EXT IN, HP out, LOOP ON
Measure DC offet voltagefrom earpiece pads. Is it ~1.38V to GND?
No
Check L150, R151,C179,C180 and line. If OK change UEM.
Measure MICB2 voltage from XMICP pads. Is it ~2.2V?
No
Yes
Audio Faults 2
Earpiece 2
Audio Faults 3

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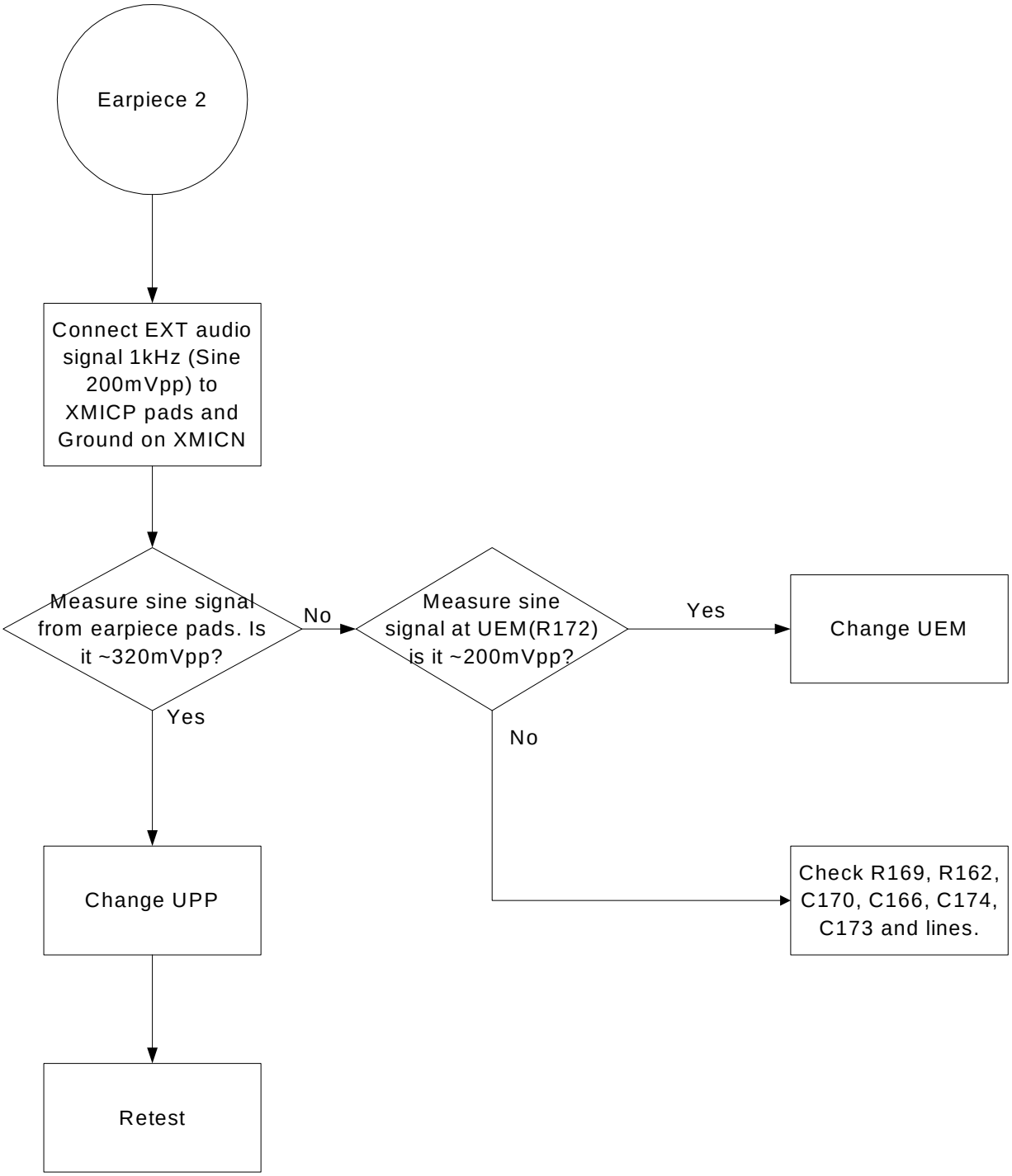
Earpiece 2
Connect EXT audio signal 1kHz (Sine 200mVpp) to XMICP pads and Ground on XMICN
Measure sine signal from earpiece pads. Is it ~320mVpp?
No
Measure sine signal at UEM(R172) is it ~200mVpp?
Yes
Change UEM
Yes
No
Change UPP
Check R169, R162, C170, C166, C174, C173 and lines.
Retest

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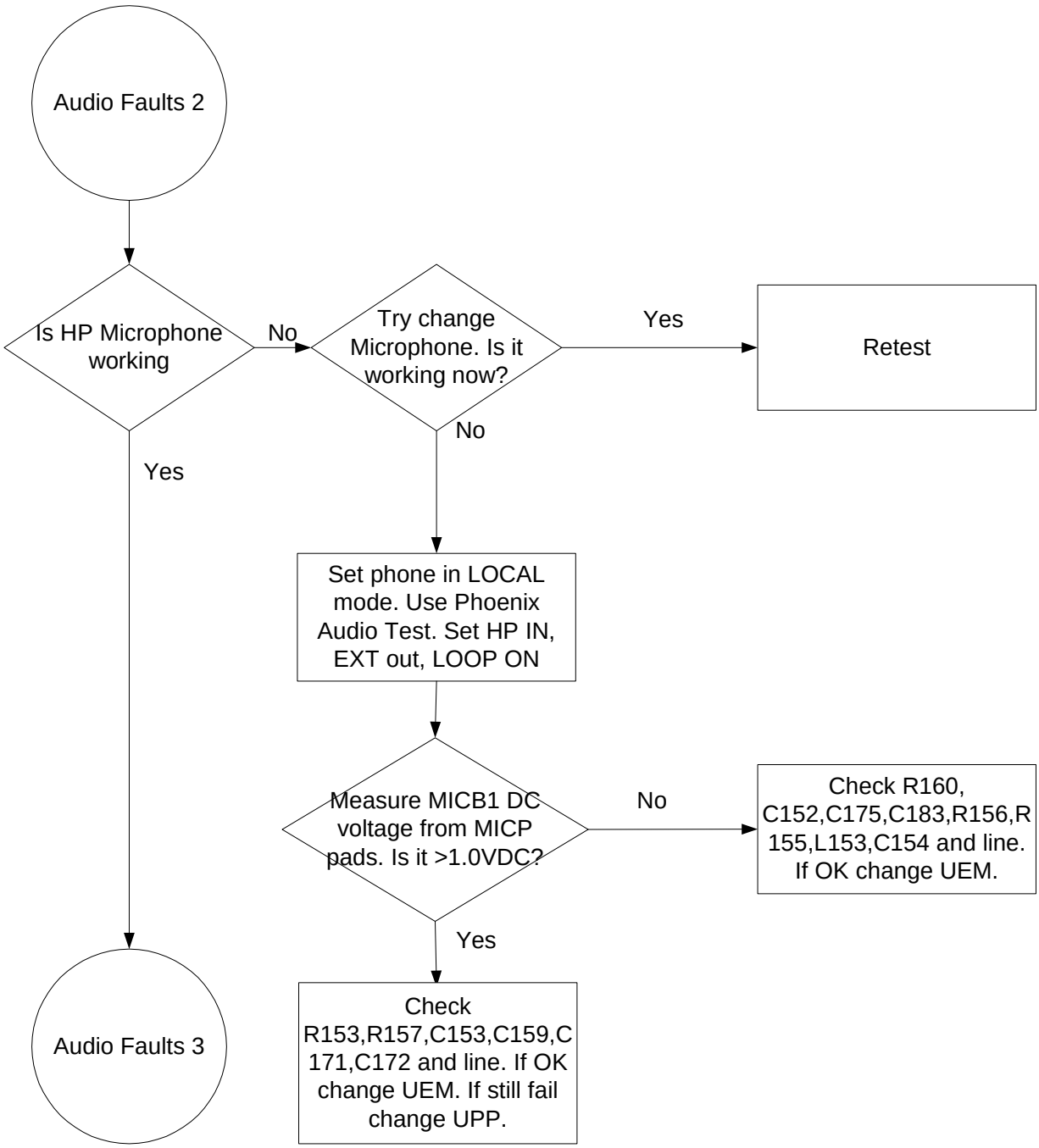
HP microphone failure


Audio Faults 2
Is HP Microphone working
No
Try change Microphone. Is it working now?
Yes
Retest
No
Yes
Set phone in LOCAL mode. Use Phoenix Audio Test. Set HP IN, EXT out, LOOP ON
Measure MICB1 DC voltage from MICP pads. Is it >1.0VDC?
No
Check R160, C152,C175,C183,R156,R155,L153,C154 and line. If OK change UEM.
Yes
Audio Faults 3
Check R153,R157,C153,C159,C171,C172 and line. If OK change UEM. If still fail change UPP.

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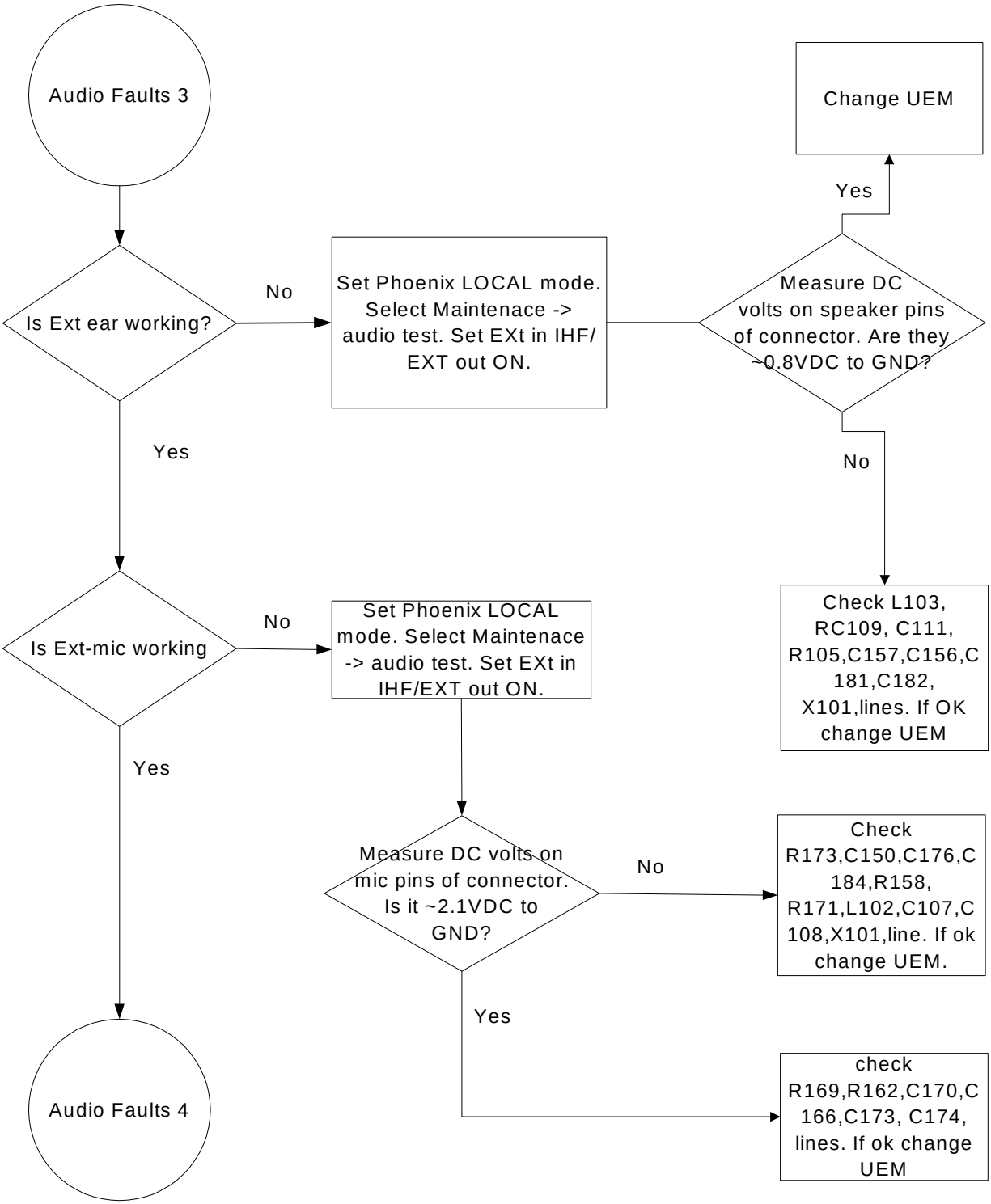
External earpiece failure


Audio Faults 3
Is Ext ear working?
No
Set Phoenix LOCAL mode. Select Maintenace -> audio test. Set EXt in IHF/ EXT out ON.
Measure DC volts on speaker pins of connector. Are they ~0.8VDC to GND?
Yes
Change UEM
No
Check L103, RC109, C111, R105,C157,C156,C181,C182, X101,lines. If OK change UEM
Yes
Is Ext-mic working
No
Set Phoenix LOCAL mode. Select Maintenace -> audio test. Set EXt in IHF/EXT out ON.
Yes
Measure DC volts on mic pins of connector. Is it ~2.1VDC to GND?
No
Check R173,C150,C176,C184,R158, R171,L102,C107,C108,X101,line. If ok change UEM.
Yes
check R169,R162,C170,C166,C173, C174, lines. If ok change UEM
Audio Faults 4

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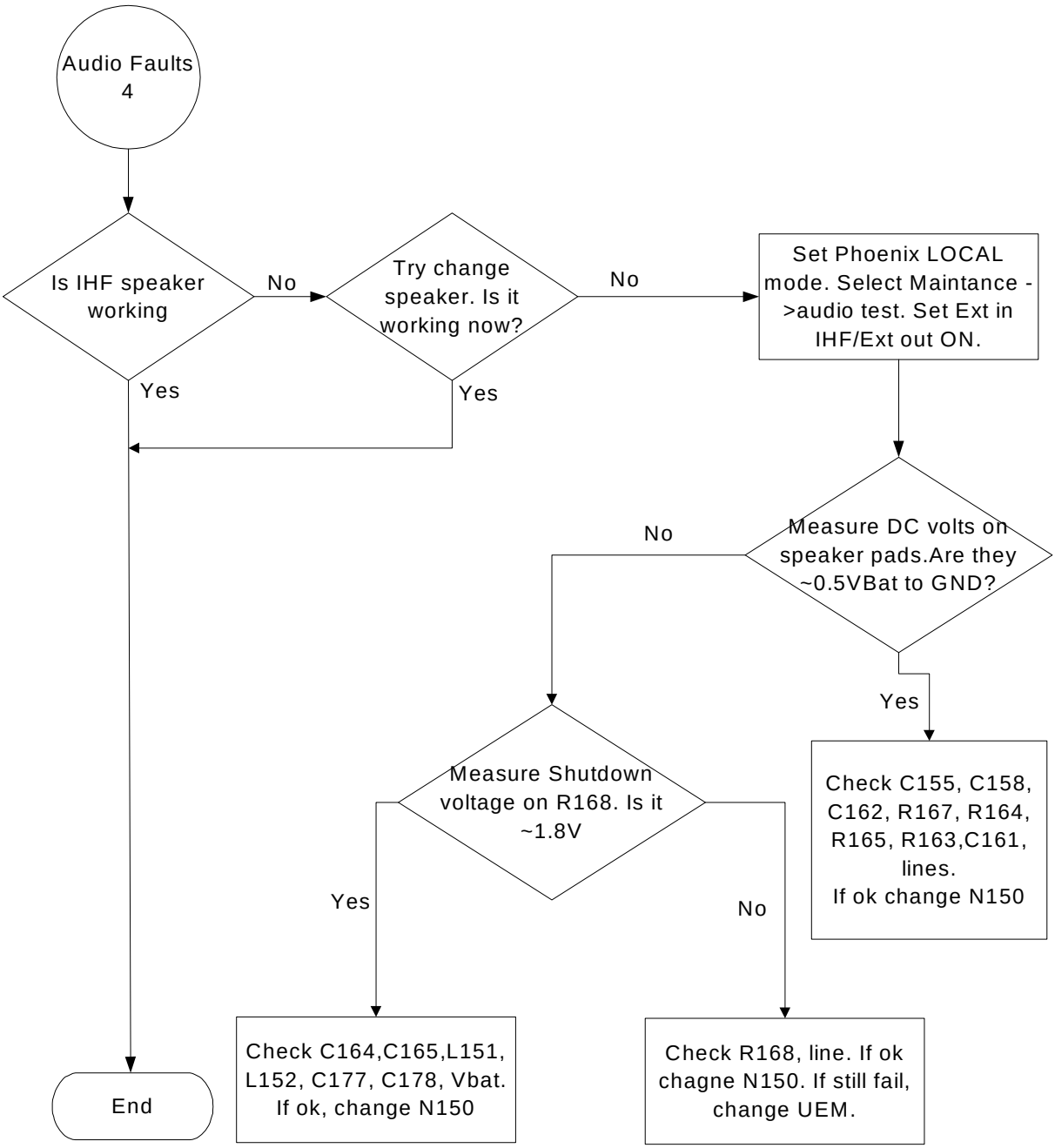
IHF speaker failure


Audio Faults 4
Is IHF speaker working
No
Try change speaker. Is it working now?
No
Set Phoenix LOCAL mode. Select Maintance ->audio test. Set Ext in IHF/Ext out ON.
Yes
Yes
Measure DC volts on speaker pads.Are they ~0.5VBat to GND?
No
Yes
Check C155, C158, C162, R167, R164, R165, R163,C161, lines.
If ok change N150
Measure Shutdown voltage on R168. Is it ~1.8V
Yes
No
Check C164,C165,L151, L152, C177, C178, Vbat. If ok, change N150
Check R168, line. If ok chagne N150. If still fail, change UEM.
End

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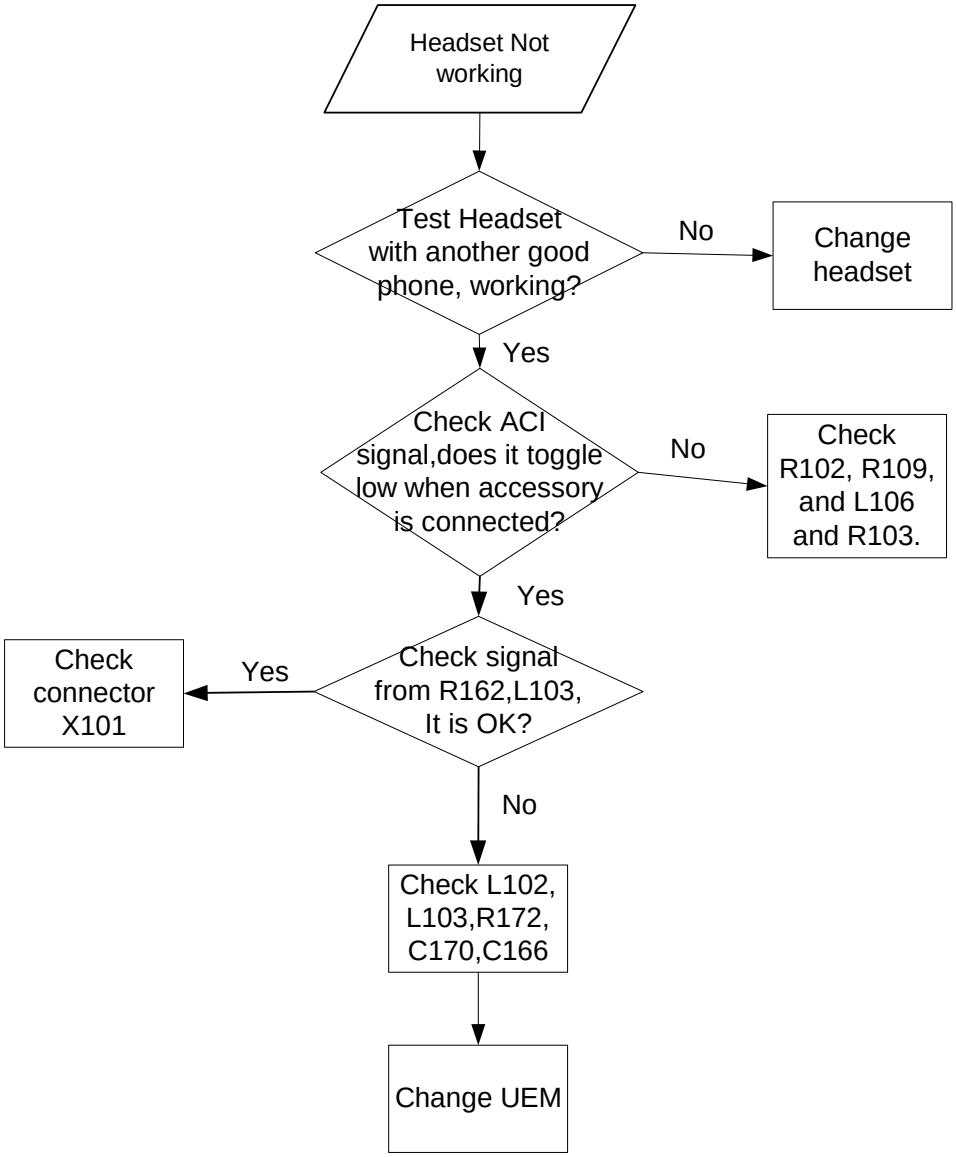
Accessory detection troubleshooting



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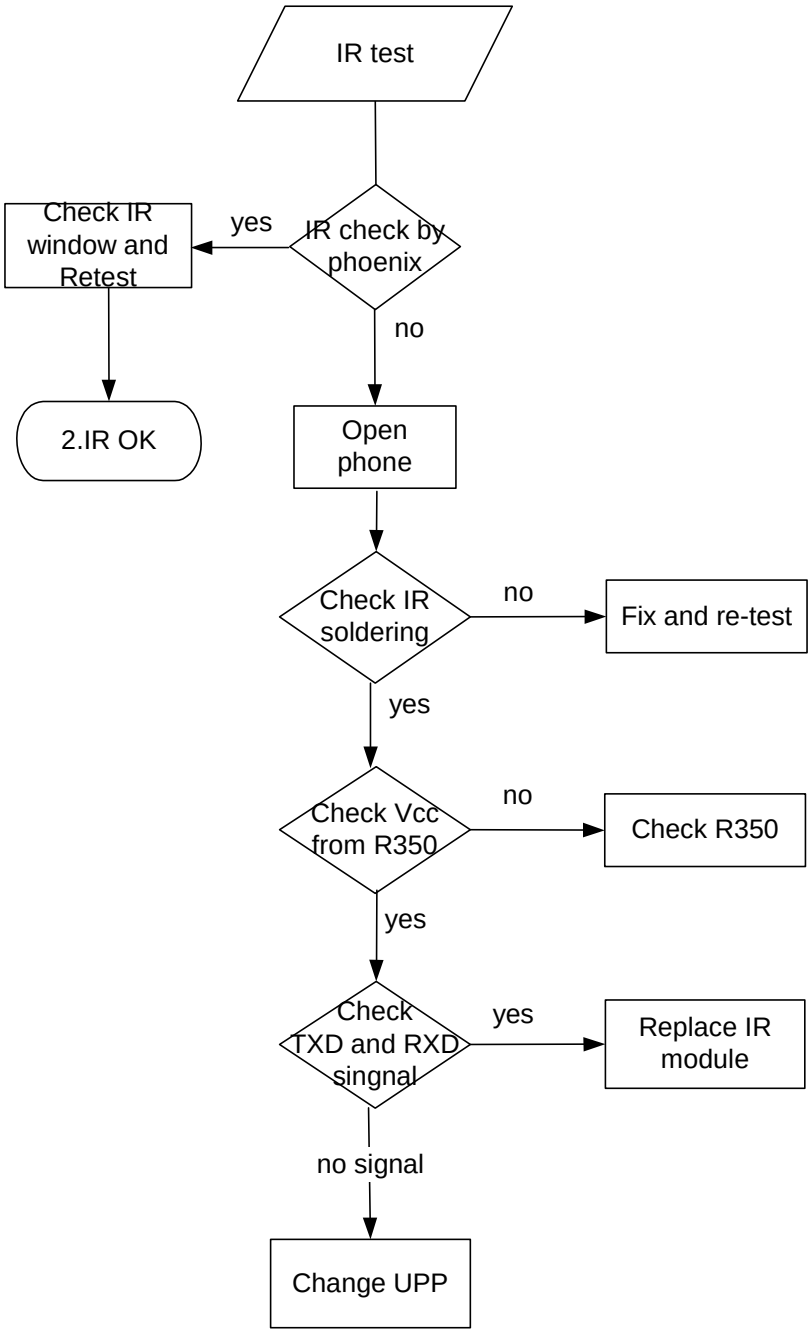
IrDA failure



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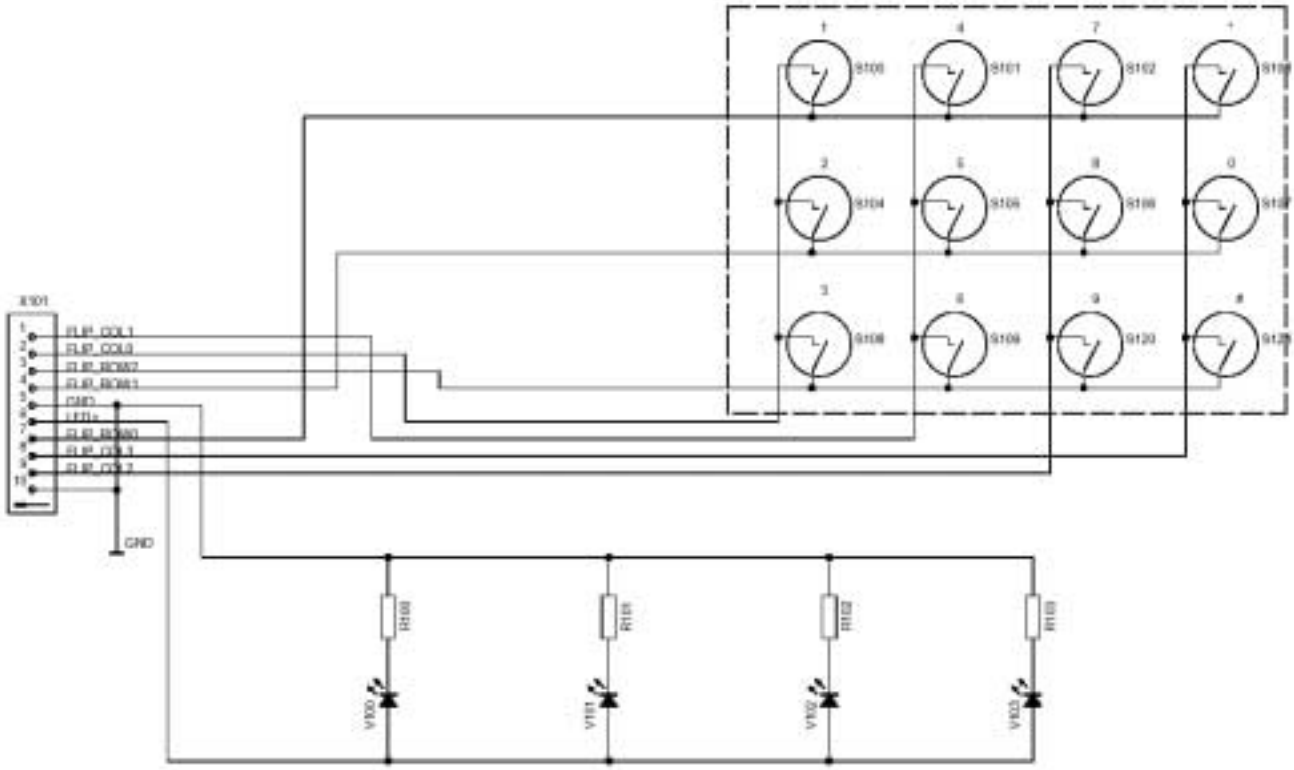
UI failure

The electrical connection of flip module, 1ah, is illustrated:



Electrical connection of flip flexi

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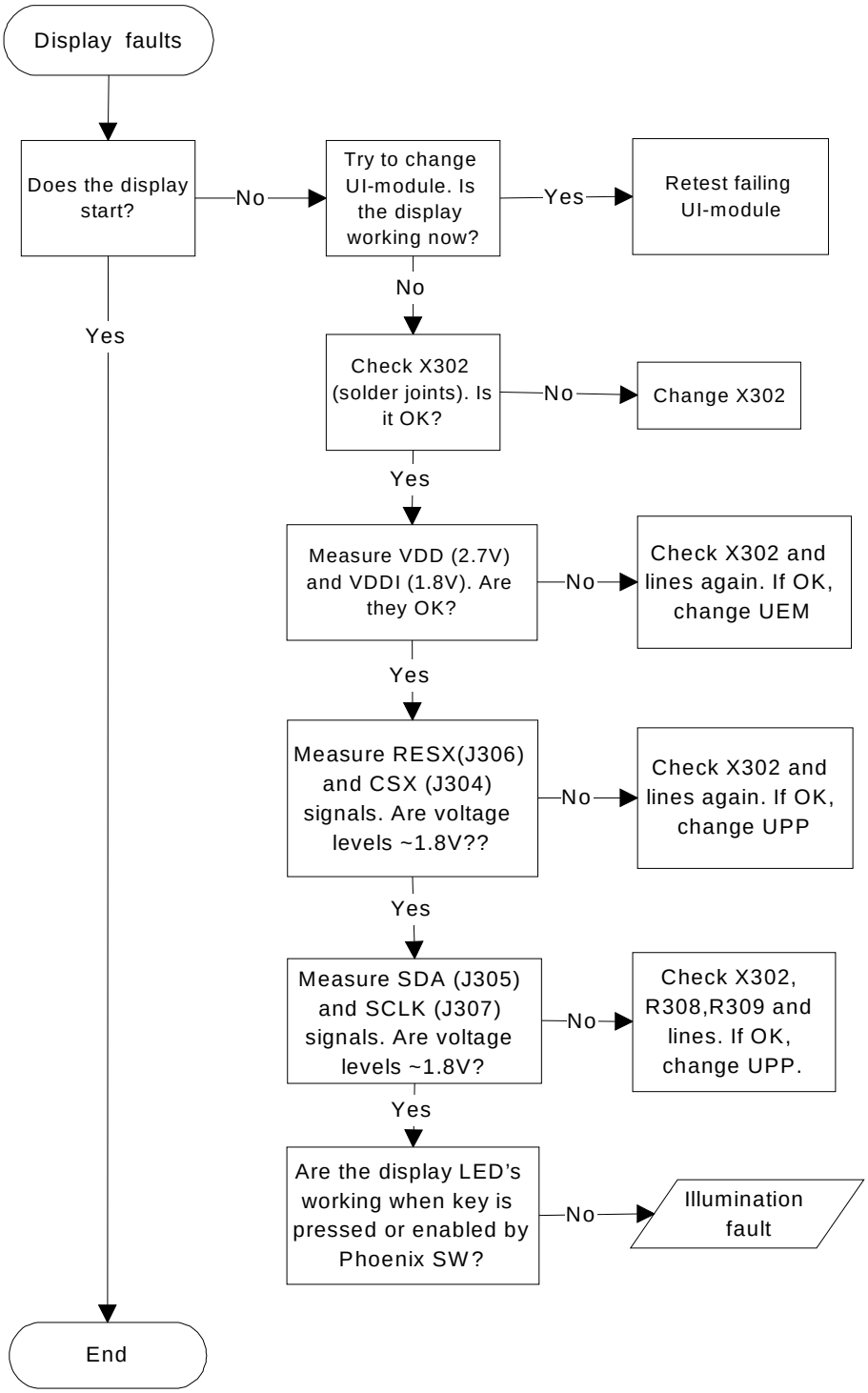
UI module - display


Display faults
Does the display start?
No
Try to change UI-module. Is the display working now?
Yes
Retest failing UI-module
No
Yes
Check X302 (solder joints). Is it OK?
No
Change X302
Yes
Measure VDD (2.7V) and VDDI (1.8V). Are they OK?
No
Check X302 and lines again. If OK, change UEM
Yes
Measure RESX(J306) and CSX (J304) signals. Are voltage levels ~1.8V??
No
Check X302 and lines again. If OK, change UPP
Yes
Measure SDA (J305) and SCLK (J307) signals. Are voltage levels ~1.8V?
No
Check X302, R308,R309 and lines. If OK, change UPP.
Yes
Are the display LED's working when key is pressed or enabled by Phoenix SW?
No
Illumination fault
End

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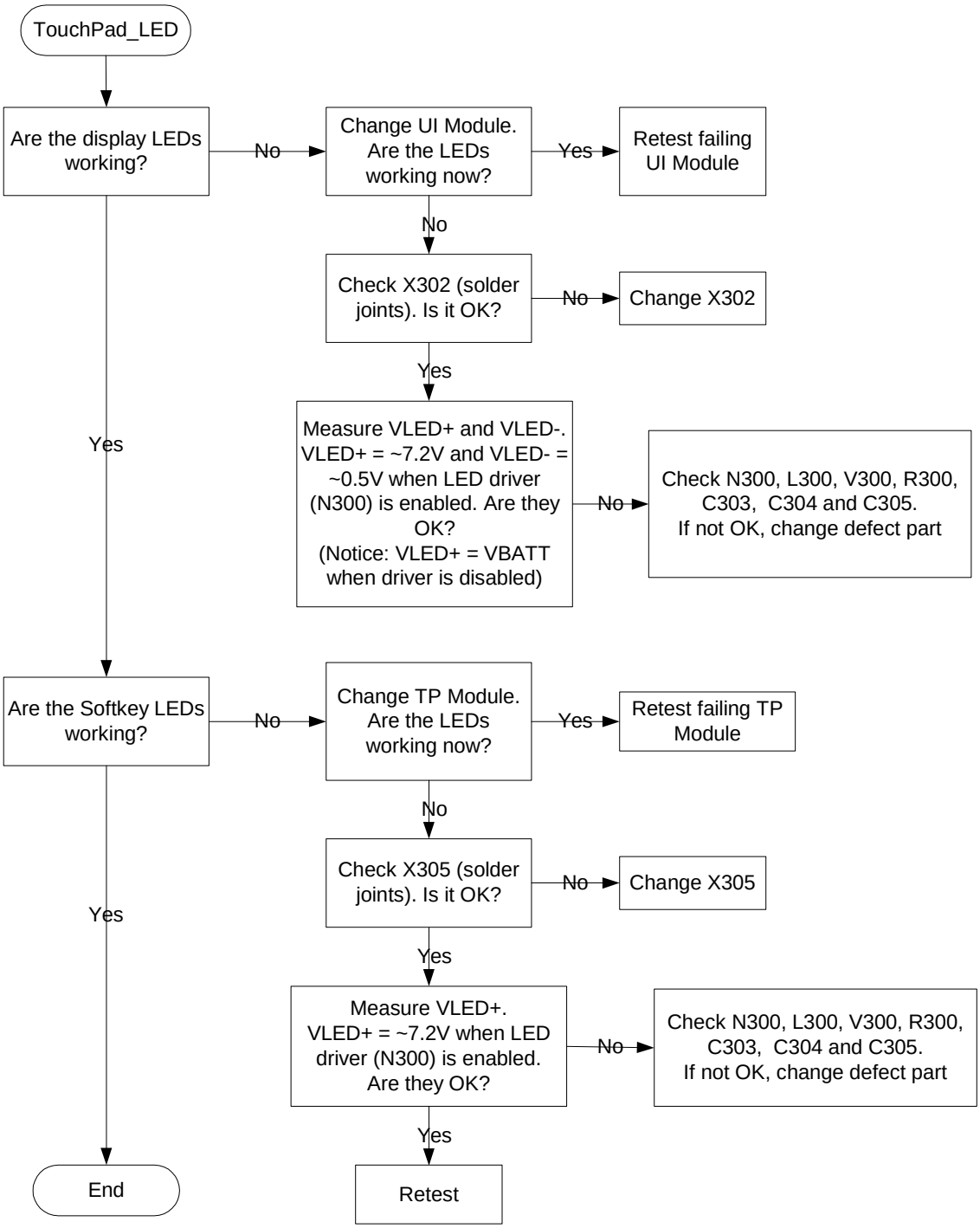
UI module and touchpad module - LED


TouchPad_LED
Are the display LEDs working?
No
Change UI Module. Are the LEDs working now?
Yes
Retest failing UI Module
No
Check X302 (solder joints). Is it OK?
No
Change X302
Yes
Measure VLED+ and VLED-. VLED+ = ~7.2V and VLED- = ~0.5V when LED driver (N300) is enabled. Are they OK? (Notice: VLED+ = VBATT when driver is disabled)
No
Check N300, L300, V300, R300, C303, C304 and C305. If not OK, change defect part
Yes
Are the Softkey LEDs working?
No
Change TP Module. Are the LEDs working now?
Yes
Retest failing TP Module
No
Check X305 (solder joints). Is it OK?
No
Change X305
Yes
Measure VLED+. VLED+ = ~7.2V when LED driver (N300) is enabled. Are they OK?
No
Check N300, L300, V300, R300, C303, C304 and C305. If not OK, change defect part
Yes
Yes
End
Retest

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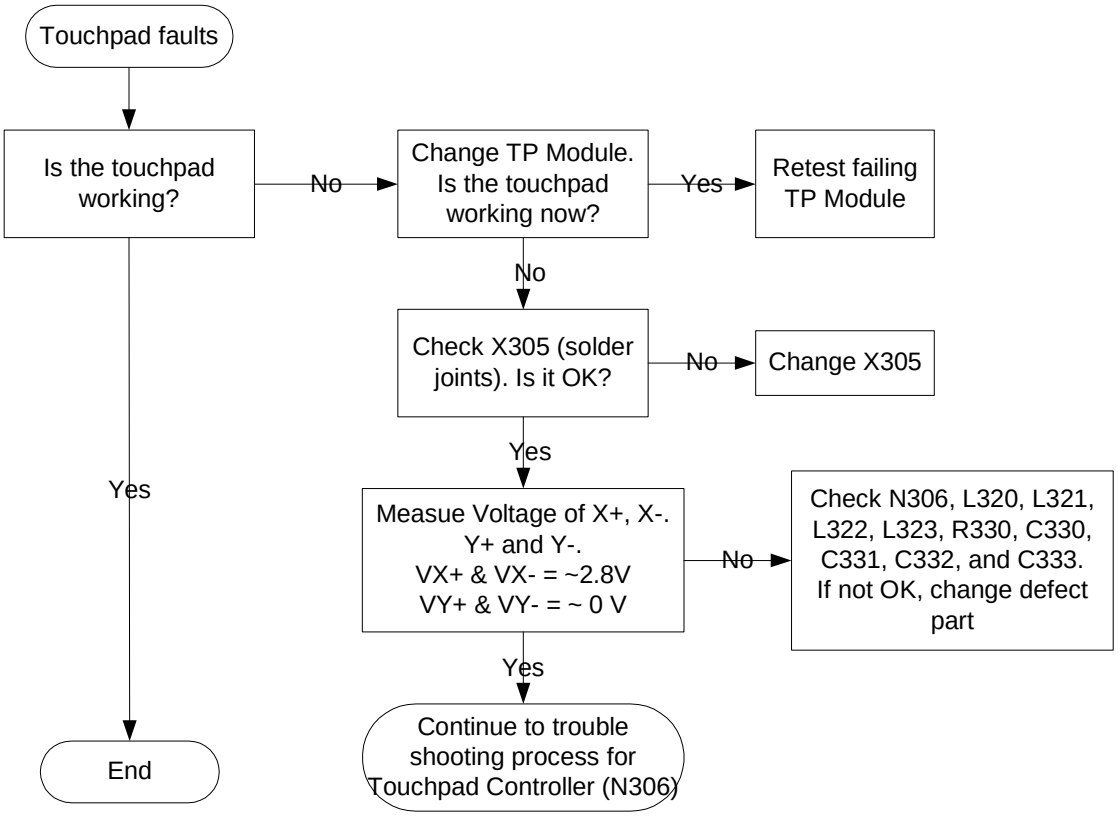
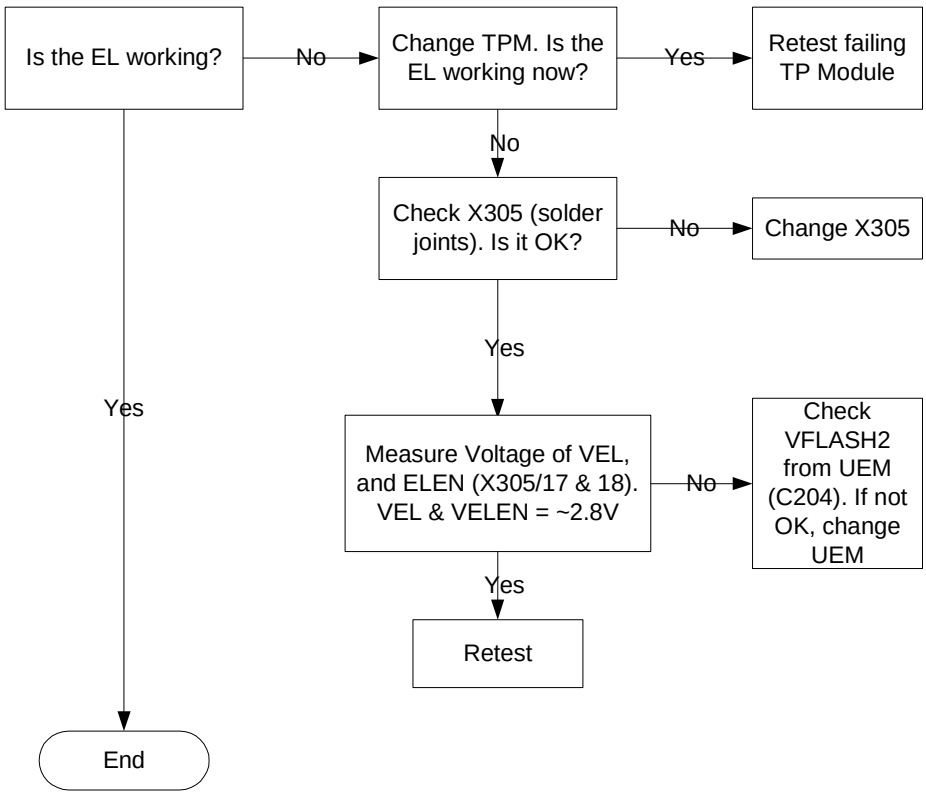
Touchpad module - Touchpad


Touchpad faults
Is the touchpad working?
No
Change TP Module. Is the touchpad working now?
Yes
Retest failing TP Module
No
Check X305 (solder joints). Is it OK?
No
Change X305
Yes
Yes
Measue Voltage of X+, X-. Y+ and Y-. VX+ & VX- = ~2.8V VY+ & VY- = ~ 0 V
No
Check N306, L320, L321, L322, L323, R330, C330, C331, C332, and C333. If not OK, change defect part
Yes
Continue to trouble shooting process for Touchpad Controller (N306)
End

Touchpad module - EL



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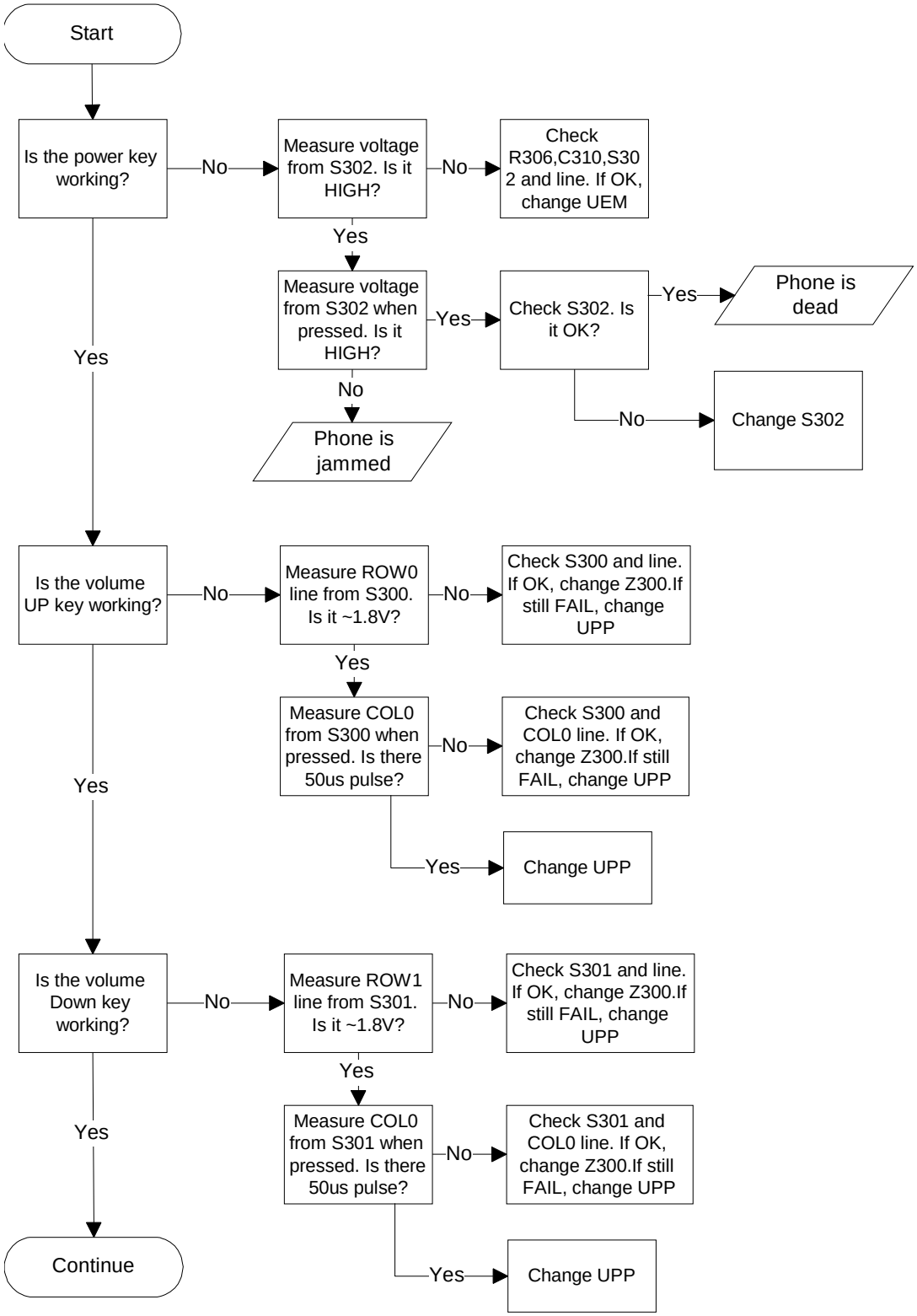
Power key and side keys


Start
Is the power key working?
No
Measure voltage from S302. Is it HIGH?
No
Check R306,C310,S302 and line. If OK, change UEM
Yes
Measure voltage from S302 when pressed. Is it HIGH?
Yes
Check S302. Is it OK?
Yes
Phone is dead
No
Change S302
No
Phone is jammed
Yes
Is the volume UP key working?
No
Measure ROW0 line from S300. Is it ~1.8V?
No
Check S300 and line. If OK, change Z300.If still FAIL, change UPP
Yes
Measure COL0 from S300 when pressed. Is there 50us pulse?
No
Check S300 and COL0 line. If OK, change Z300.If still FAIL, change UPP
Yes
Change UPP
Yes
Is the volume Down key working?
No
Measure ROW1 line from S301. Is it ~1.8V?
No
Check S301 and line. If OK, change Z300.If still FAIL, change UPP
Yes
Measure COL0 from S301 when pressed. Is there 50us pulse?
No
Check S301 and COL0 line. If OK, change Z300.If still FAIL, change UPP
Yes
Change UPP
Yes
Continue

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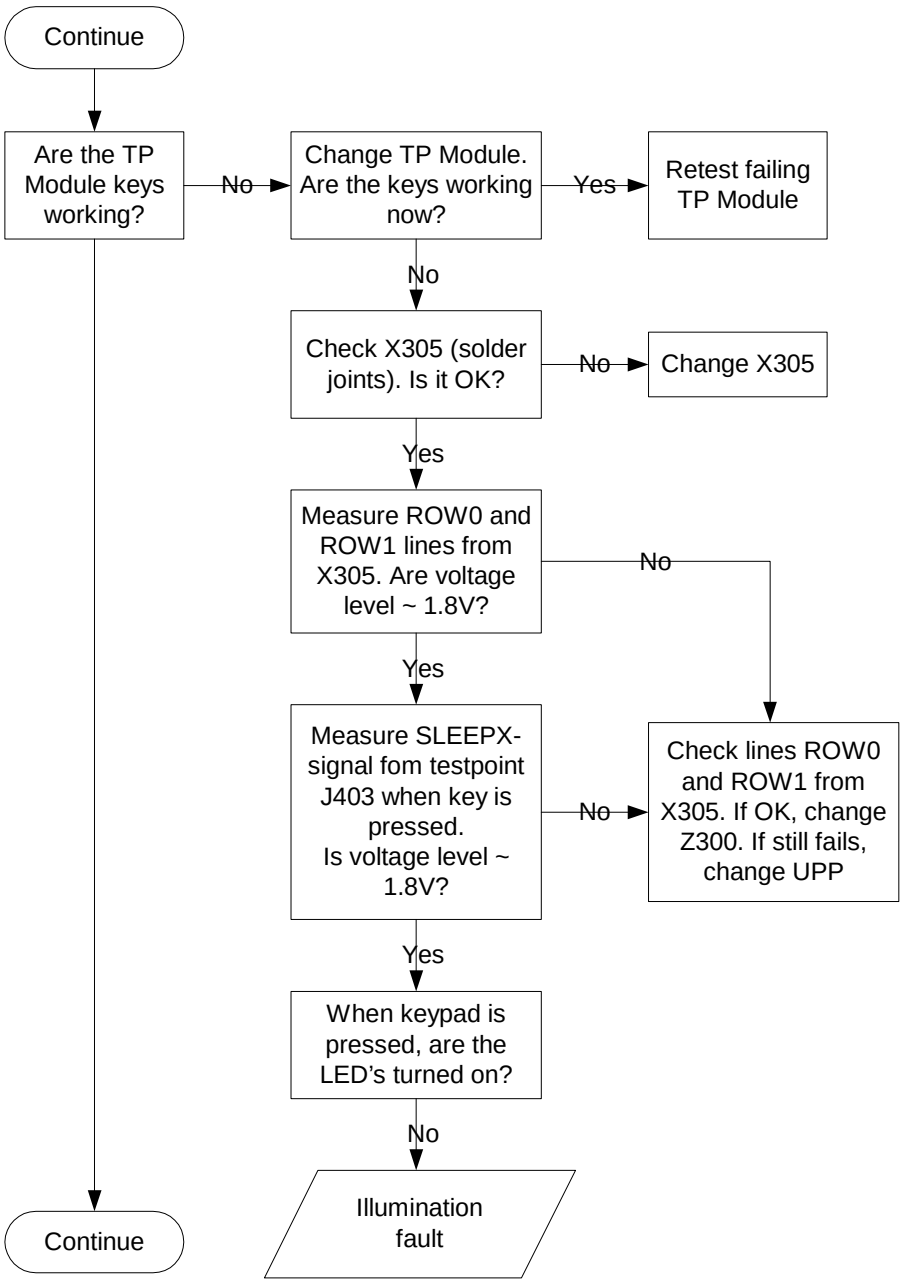
Touchpad module - Softkeys


Continue
Are the TP Module keys working?
No
Change TP Module. Are the keys working now?
Yes
Retest failing TP Module
No
Check X305 (solder joints). Is it OK?
No
Change X305
Yes
Measure ROW0 and ROW1 lines from X305. Are voltage level ~ 1.8V?
No
Yes
Measure SLEEPX-signal fom testpoint J403 when key is pressed. Is voltage level ~ 1.8V?
No
Check lines ROW0 and ROW1 from X305. If OK, change Z300. If still fails, change UPP
Yes
When keypad is pressed, are the LED's turned on?
No
Illumination fault
Continue

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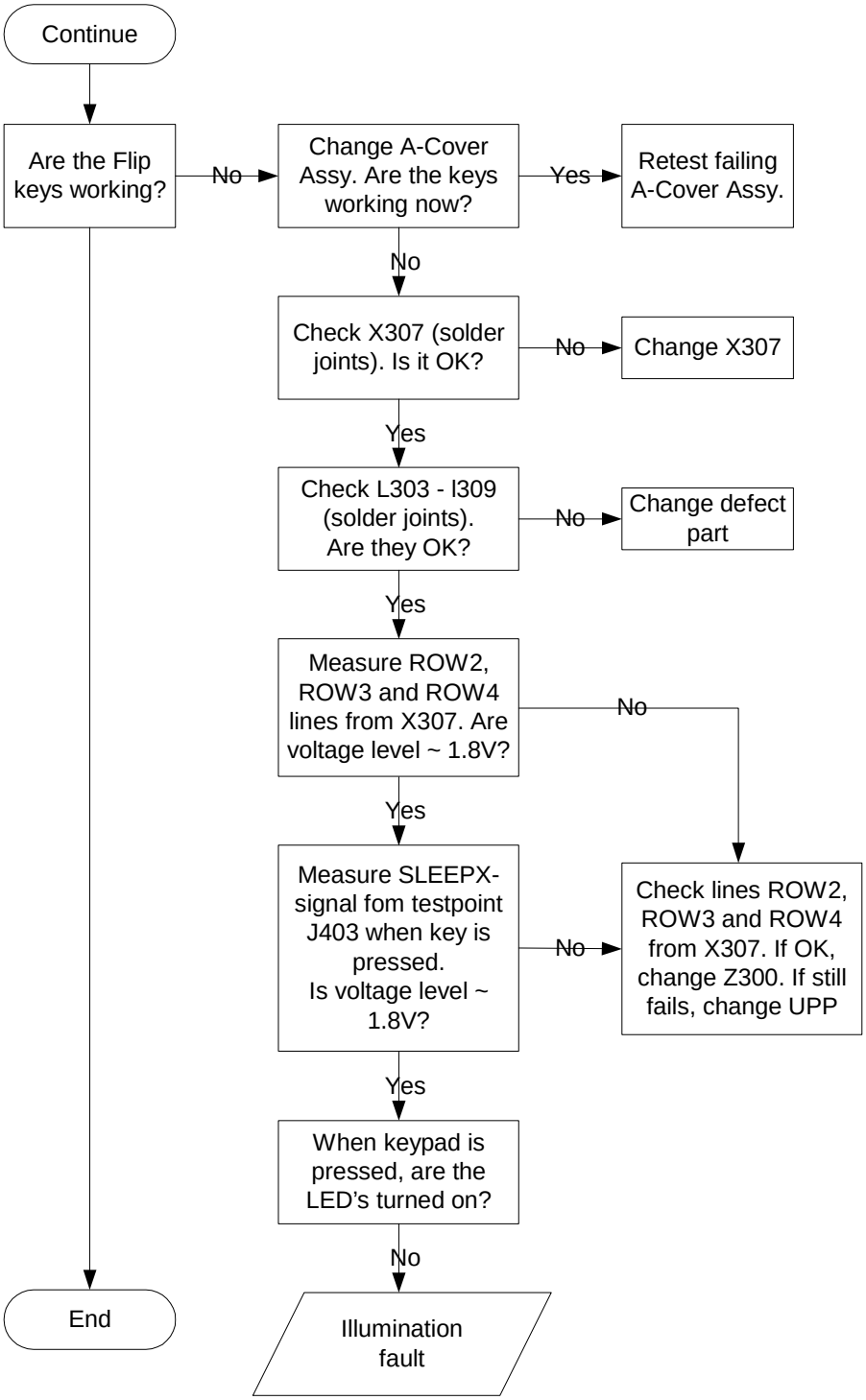
A-cover assembly - keyboard


Continue
Are the Flip keys working?
No
Change A-Cover Assy. Are the keys working now?
Yes
Retest failing A-Cover Assy.
No
Check X307 (solder joints). Is it OK?
No
Change X307
Yes
Check L303 - l309 (solder joints). Are they OK?
No
Change defect part
Yes
Measure ROW2, ROW3 and ROW4 lines from X307. Are voltage level ~ 1.8V?
No
Yes
Measure SLEEPX-signal fom testpoint J403 when key is pressed. Is voltage level ~ 1.8V?
No
Check lines ROW2, ROW3 and ROW4 from X307. If OK, change Z300. If still fails, change UPP
Yes
When keypad is pressed, are the LED's turned on?
No
End
Illumination fault

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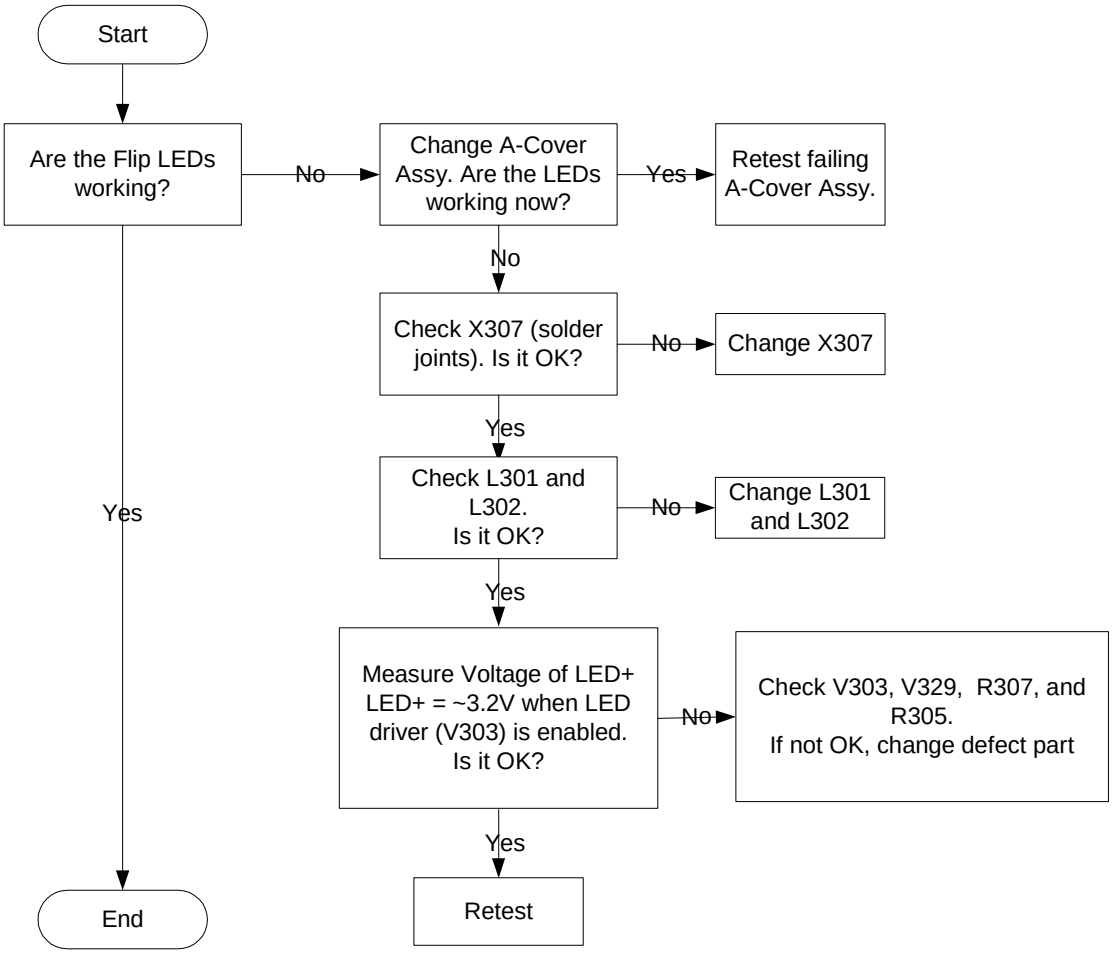
A-cover assembly - LED



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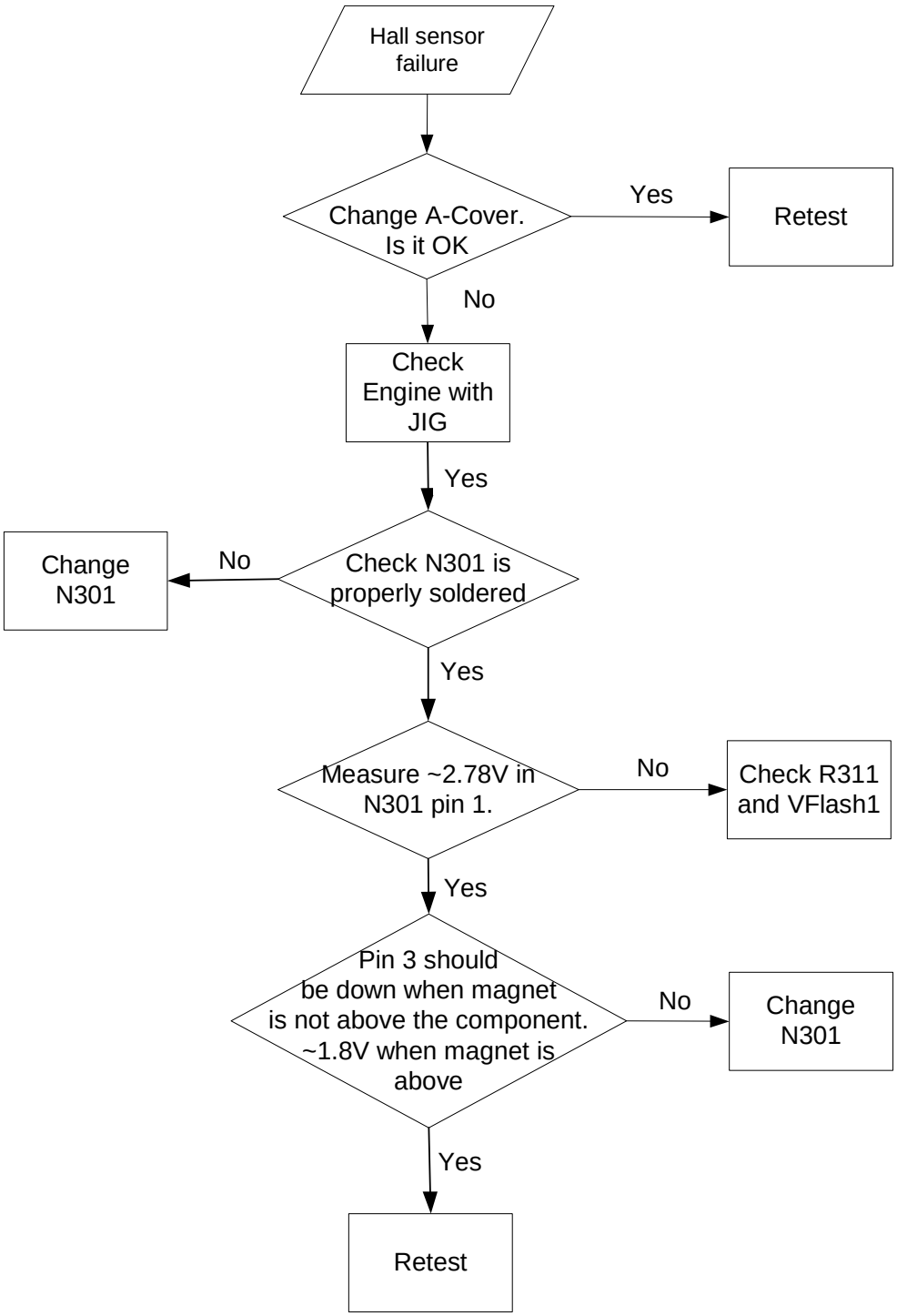
Hall sensor no failure



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